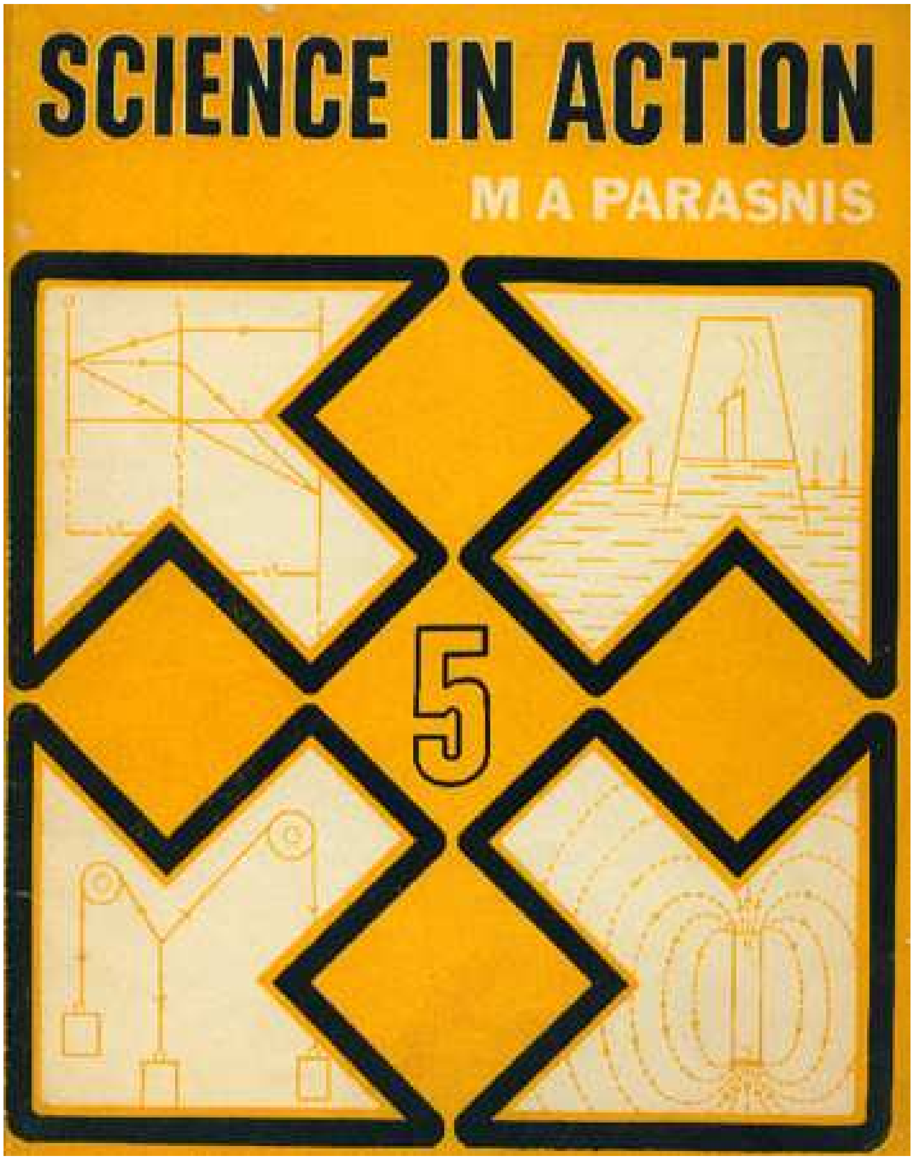

SCIENCE IN ACTION

M. A. PARASNIS

BOOK 5

First Published 1976

PREFACE

Doing an experiment is fun
And is the best way to learn

The series 'Science in Action' is written specially to help children in the age group eight to thirteen years to have first hand experience in science. It is designed so as to help the classroom teacher make the learning of science an enjoyable and rewarding experience for herself/himself as well as for her/his class. Interested parents could also easily use the series to help their children to do science at home. Enthusiastic children could even use it on their own at home and school.

The series consists of five books: Book I for class four (age 8-9 years), Book II for class five (age 9-10 years), Book III for class six (age 10-11 years), Book IV for class seven (age 11-12 years) and Book V for class eight (age 12-13 years). It is not designed to cover the syllabus of any particular school system or state but, rather, to uncover a little part of the fascinating world of science, taking into consideration the average mental and physical capabilities of the respective age groups.

Essentially these are books of science activities. These typical activities, selected from various areas of science, use *readily available* and *Inexpensive materials* like jam and milk bottles, coffee tins, paper cartons, thread, string, wire, paper clips and pins, rubber bands, balloons, drinking straws, etc. Many classic experiments, described in text books unchanged for generations, have been performed more interestingly and instructively. Many more have been added. Each activity has been tried and tested out, so to say, in the *field.* They all involve experimentation resulting in experience with important scientific principles. The involvement is qualitative and thus maintains a high level of interest.

These books are the culmination of a decade of involvement in school education (on the campus of the Indian Institute of Technology Kanpur) into which I was initiated and inducted by the Institute's first Director, Dr P K Kelkar. It was his faith in the tremendous potential of children and his keen insight into the way they learn which 1 made him start a school on the campus under IIT/K Administration. The School had complete freedom to try out new methods in teaching and learning. It was at the IIT/K Campus School that many of the seeds of the present series were sown. It was the encouraging response from children and teachers of that school that gave me the enthusiasm to complete the work.

Thanks are due to the Education Development Centre, IIT/K, funded by NCSE/NCERT, for grants which have supported this venture and have made it possible for each and every activity in this series to be actually tested out.

For books such as these good illustrations are essential. They save many words of description and are a special attraction for the children. I would like to record my appreciation for the patient and painstaking work done on illustrations by Mr. A C Joshi of the Department of Electrical Engineering, IIT, Kanpur.

My husband, Dr Arawind S Parasnis, Professor of Physics, IIT, Kanpur, has read the manuscript critically and made innumerable valuable suggestions. He and my sons, Kaushik and Gautam, have provided that understanding cooperation without which I could not have enjoyed writing the series. My sons were often the guinea pigs for testing out these activities.

The series is dedicated to children—the mini-scientists—and their teachers. If you have enjoyed the books, do let me know along with corrections and comments, if any.

Meera A. Parasnis

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INTRODUCTION

Science today plays a significant and ever-increasing role in the social and economic life of ordinary man. The impact of scientific and technological progress not only has permeated urban and suburban life but also is fast penetrating into remote villages. New varieties of seeds, the tractor, the transistor radio and the antibiotics have reached the farthest corners of our country. Many villages have been electrified. Satellite Instruction Television Experiment (SITE) has already taken television to a number of villages. Training in science is essential to the improvement of health and living conditions of our people and to the promotion of agriculture and industry. It is, therefore, increasingly important for everybody to be literate in science. This need embraces all age-levels, alt socio-economic levels and all intelligence levels. However, it is for the children of today, the arbiters of our fate tomorrow, that the need is the greatest. Unless we give our children scientific schooling we cannot hope for a bright future for our country.

Till very recently, no one studied science unless one entered middle/high school. Some schools did teach a few lessons about birds and flowers. All that was available was a few books of nature stories and study.

Since Independence the field of science education has undergone a big change. Most of the changes stem from a dual attempt. First, there has been an increase in the quantity of subject matter taught. Second, there has been an attempt at re-establishing the class levels at which various topics would be taught: a part of what was done in high school is now sought to be done in the middle school and, in the same way, a part of what was done in the middle school is sought to be handed over to the primary school.

However, students are doing more reading in science. They are reading about science but not doing science. This is like attempting to teach a person to swim by having him read the best books on swimming rather than plunge into water.

In short, the science programme in our schools is still around the text books. Science is viewed by teachers (and consequently by children) as a body of facts and a set of answers, absolute and immutable, which explain the universe. Often these explanations come in the form of one word or phrase taught by the teacher and learnt by heart by the taught. When a phenomenon is demonstrated, the children simply associate the questions about the phenomenon with the word or phrase without understanding conceptually the interactions involved. Natural phenomena are used not as stimuli to regenerative thinking and to the spirit of discovery but merely as examples of or adjuncts to facts already presented. Thus a bug floating on water is an example of surface tension. A ship, though made of steel, floating on the sea is an example of Archimedes' principle. The horse pulling the cart and the cart pulling the horse is an example of Newton's law of reaction. Can we blame the child?

This inevitably helps erect a barrier between the child and science. This barrier must be broken. When such barriers are broken science becomes not only interesting but also a part of the child's thinking. This requires a child's active involvement in his own learning. Experimenting is an excellent chance to stimulate thinking. There is joy and excitement in working with one's own hands for man is basically a builder. Children

need to work with their own hands and talk and argue about their work. They should get involved with science and discover its principles for themselves. As far as possible, even demonstrations by teachers should give place to investigations by children. Children should work like little scientists busy exploring the rich world around them. It was a very wise Chinese sage who said

I hear and I forget

I see and I remember

I do and I understand

Performing experiments and learning to make close observations requires some facilities. These are lacking in most of the schools of our country—especially at the primary and middle school levels. As a result, science teaching (if it is attempted at all) suffers from a severe handicap especially at these levels. It is often believed, though erroneously, that to introduce science experience even in primary and middle schools requires elaborate equipment made by commercial manufacturers and hence needs a big budget.

The series 'Science in Action' is an attempt to use simple, easily *available, low cost materials* to set up experiments which illustrate a large variety of sophisticated scientific principles. For example, experiments are so designed that the child does not need to use wooden planks, hammer and nails; the same work is done by cardboard, bark cork and drawing pins. The experiments are not hard to set up even if you have not done much experimentation before. The series is meant for classes' four to eight and consists of five books. These are essentially books of science activities written in a simple style so as to provide teachers, teachers-in-training and children with a variety of experiments that can be used as teacher-demonstrations, children's class room activities, demonstrations at science fairs, class projects or any related science study. The activities are interesting and instructive in practical and exciting ways.

From this year the 10 + 2 + 3 pattern of education is being introduced and science and work experience courses are compulsory up to class 10. The activities in these books involve both science and work experience. A good deal of the material needed has to be built with tins, cardboard and string. Screw driver, hammer, hacksaw, cork-borers, files and planers have to be used, depending upon the level. The contents of each book can be covered during a one year period by allotting special 'activity periods' during which children will work with their own hands to produce materials with which they will learn science. Book I has 25 very simple activities which could easily be handled by children of class 4 with two periods a week. This could be increased to four periods a week for classes 5 and 6 (Books II and III which have 30 and 40 activities respectively) and six periods a week for classes 7 and 8 (Books IV and V, having 45 and 50 activities respectively). Many concepts have been repeated from book to book so that a concept can grow to a greater degree of sophistication as a child goes to higher classes.

Each activity has five parts:

(i) An attractive title

(ii) Materials: the things and the equipment needed to perform the activity

(iii) Procedure: Step by step utilization of the materials. The expected observation is usually indicated as a part of the procedure

(iv) Drawings and diagrams: for ease of assembling

(v) The 'why' of the activities is given sequentially at the end of each book. This gives scope to the child to think for herself/himself. In case she/he needs help it is readily available. This also acts as a check.

Believing that the method of science should play a significant role in any modern educational scheme, this series is offered in the hope that it will assist science teachers and students in their co-operative quest for science.

FOREWORD

It is a matter of great pleasure and honour to have this opportunity of writing a Foreword to the rather unique series of books entitled 'Science in Action' meant for children below thirteen years of age written by (Mrs) Meera A Parasnis, The time of its publication could not have been more appropriate for there seems to be a new awareness in the country of the need to make science education meaningful from the earliest level of schooling right up to the tenth standard.

Modern technology is revolutionising our entire social structure in a variety of ways. The pace of change poses challenges in every direction. It is possible neither to go back nor to advance in a systematic manner without a proper understanding of the way technological forces affect society. It is necessary to appreciate that if the fruits of technology enter the lives of men; its roots are in science. In this context understanding of science and the scientific method is as necessary for those who are going to be professional scientists as for the rest.

The essential objective of the teaching of science to children must be not so much the imparting of scientific information as creating a lively interest in the scientific method and developing a scientific attitude of mind by actual involvement in "scientific activity". This is precisely what this series of five books makes possible.

In this approach the material expenses involved are very modest, but it draws heavily on the motivation of the teachers and the taught. To observe, to ask questions, to use Imagination, to make intelligent guesses about the possible answers, are all attributes of a lively scientific attitude of mind.

There is little doubt that, if children are exposed to these activities as detailed in these books over a sufficient period of time, they will not only be familiar with the scientific method but will develop a scientific attitude of mind. Children successfully taught in this fashion will in fact begin to show the scientific approach in all their learning.

Mrs Parasnis has taken enormous pains in writing these manuals based on ten years of her direct involvement with children in the age group of 8- 13 yrs, in exposing them to real scientific activity. The material incorporated has been as though tested 'in life' and that is perhaps its greatest merit. In my view, Mrs Parasnis not only deserves congratulations but our gratitude for this timely publication.

If the experiment involved in using these manuals succeeds, as it should, then no time may be lost in making these available in various Indian languages.

P K KELKAR

"Chhaya"

H R. Mahajani Marg

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CONTENTS

1 Pop Pistol

Materials

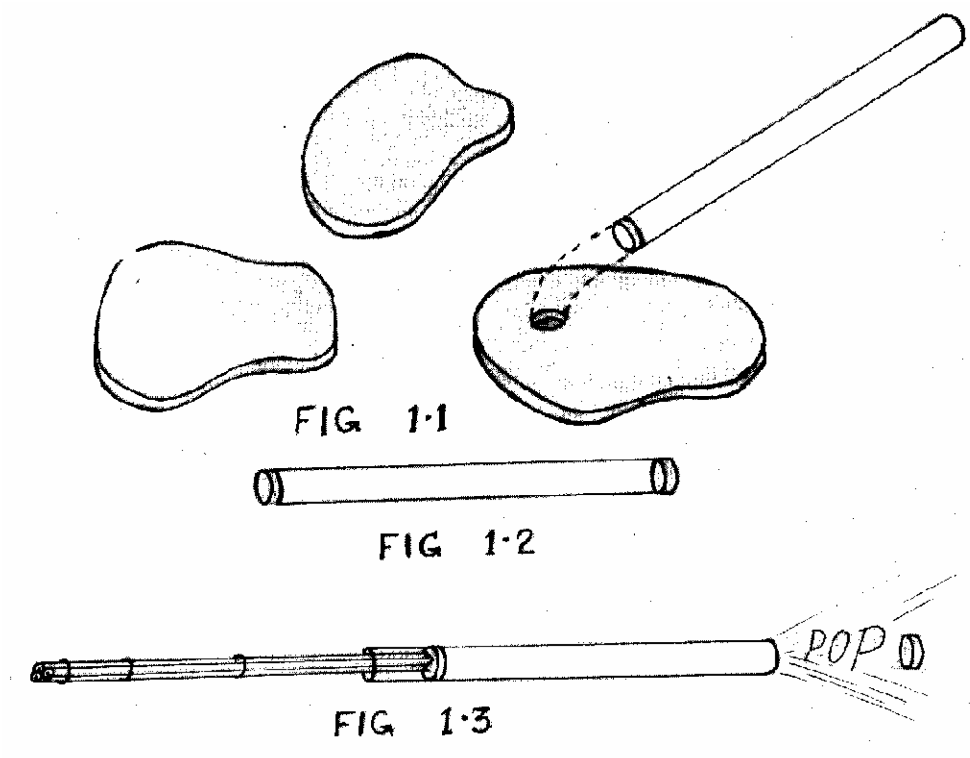
Potatoes

Cylindrical tube (glass, plastic or metal)

Pencils

Cello tape

String



Cut a potato into three approximately 1 cm thick slices.

Take a tube about 15 cm long and 2 cm in diameter. Push one end of the tube into a slice of potato so as to cut the slice. The cut part will get into the tube and seal the end *(Fig 1.1)*.

Similarly seal the other end *(Fig 1.2)*.

Tape three pencils *firmly* together. Use the string also, if necessary.

Aim one end of the tube at a suitable target (other than a friend). With the pencils, push the potato at the other end.

Keep pushing and you *suddenly* hear a loud pop. The potato at the front end goes out like a bullet *(Fig 1.3)*.

Push the remaining piece of potato to the front end. Cut a new slice of potato with the tube. The pistol is ready to be fired again.

Find out why the potato pistol pops.

2 The Mystifying Fountain*

Materials

Two large tins (soy empty mobil-oil tins)

Two corks (preferably rubber) to fit the tins

Glass tubing

Coloured water

Glass nozzle (soy from an eye-dropper)

Rubber tubing (to fit the glass tubing)

Funnel

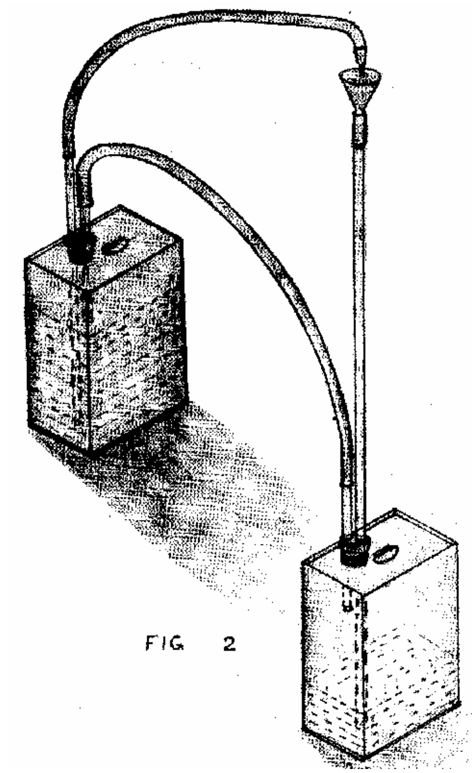


FIG 2

Take two large tins and find corks that fit them well. Make two holes in each cork so that the glass tubing fits into the holes.

Fill one tin with coloured water and place it higher than the other tin which should be empty.

With the help of rubber tubing arrange two short glass tubes and two long glass tubes through the holes in the corks as shown in Fig 2. The end of the nozzle from the higher tin should be held over the mouth of the funnel from the lower tin.

Pour water into the funnel *until* a stream of water spurts out from the nozzle into the funnel *(Fig* 2).

Wait and watch.

The mystifying fountain will keep on working until the lower tin is full of water.

Why?

*An adaptation of the famous Hero’s fountain.

3 Straw Hydrometer

Materials

Candle Pan

Boiling water

Drinking straw

Paint brush

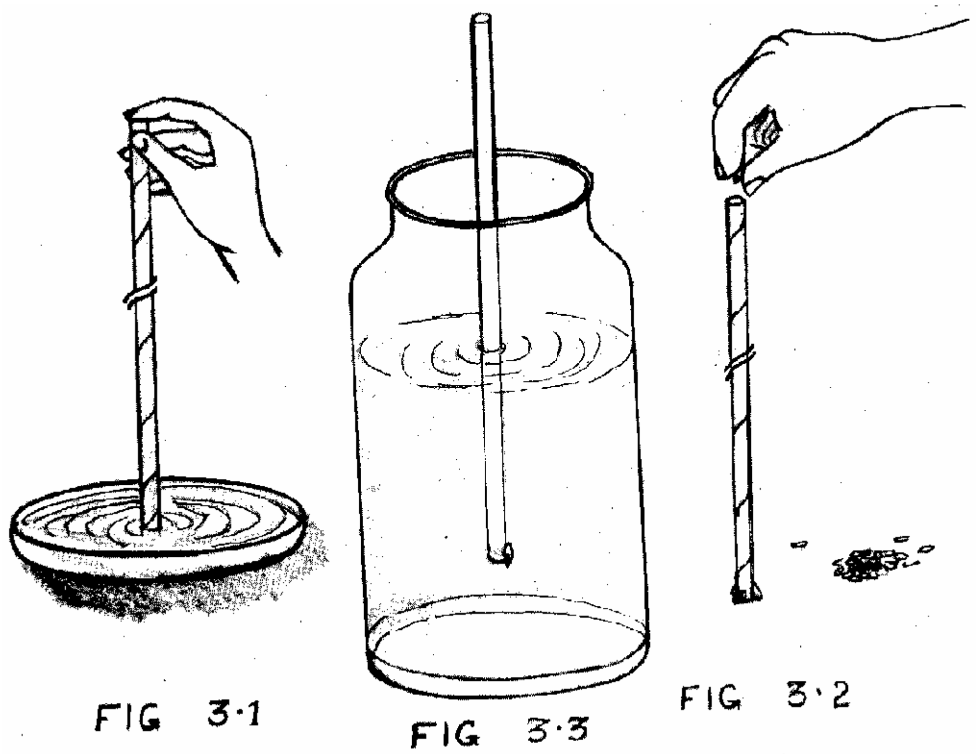
Wire

Pair of pliers

Cotton

Water

Different liquids (e.g. milk, kerosene, etc)



Melt a small quantity of candle wax in a pan by holding the pan in boiling water.

With a paint brush, coat a drinking straw with a thin layer of wax. This strengthens the straw and prevents liquids from soaking it.

Dip one end of the straw into molten wax up to about 1 cm *(Fig 3.1)*. Take the straw out and the wax solidifies. This seals the end.

Drop a few wire bits into the open end of the straw. They will rest against the wax plug *(Fig 3.2)*. Do this till the straw floats upright in water *(Fig* 3.3).

Push a small piece of cotton down the open end to keep the wire bits in position. The straw hydrometer is ready for use.

Float the hydrometer in water and measure the length of the straw from the bottom to the water level. Repeat for milk, salt water, kerosene, glycerine, etc.

Specific gravity of a liquid =

(Length of the straw below water-level) / (Length of the straw below liquid-level)

Calculate the specific gravity of the various liquids.

4 Steam-jet propelled Boat

Materials

Old tin

Tin shears

Small empty tin (soy from tooth powder, film roll)

Soap dish (metal)

Needle

Small candle

Coca-cola cap

Large tub (or basin)

Water

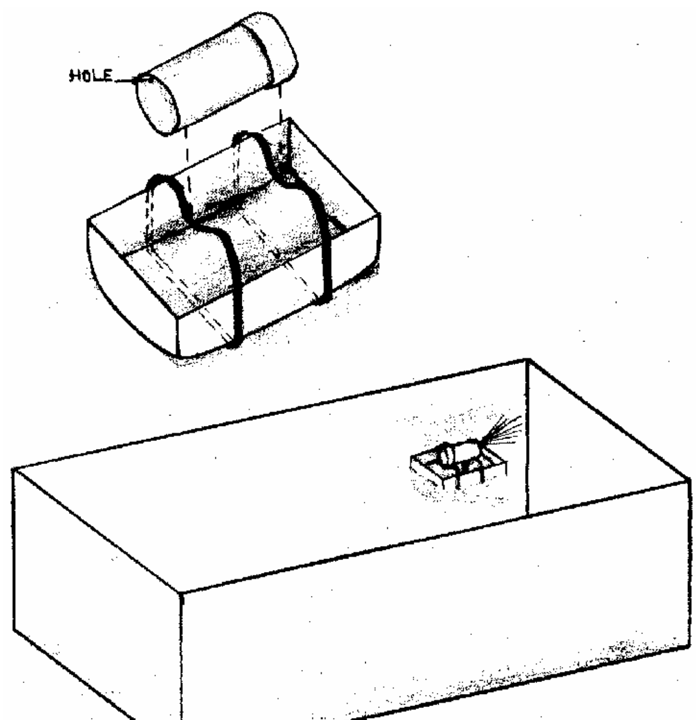


FIG 4·2

Cut two long metal strips about *1* cm wide from an old tin.

Bend the strips into a stand to hold a small tin on a soap dish *(Fig 4.1).*

With a needle make a small hole near the edge, on the base of the small tin. Put some water in the tin and close the lid tightly. Make sure that the lid is air-tight.

Place the tin on the stand with the hole at the highest point. Put a small candle on the coca-cola cap and keep it in the soap dish under the tin.

Float the soap dish on water in a large tub. Make sure that the tin is horizontal.

Light the candle.

What happens as the water in the small tin is heated?

In a short time, steam starts coming out of the hole in the small tin and the boat starts moving on the surface of the water *(Fig 4.2)*.

Note the direction of the steam and the movement of the soap-dish boat. Explain why the boat moves.

5 Match stick Rocket

Materials

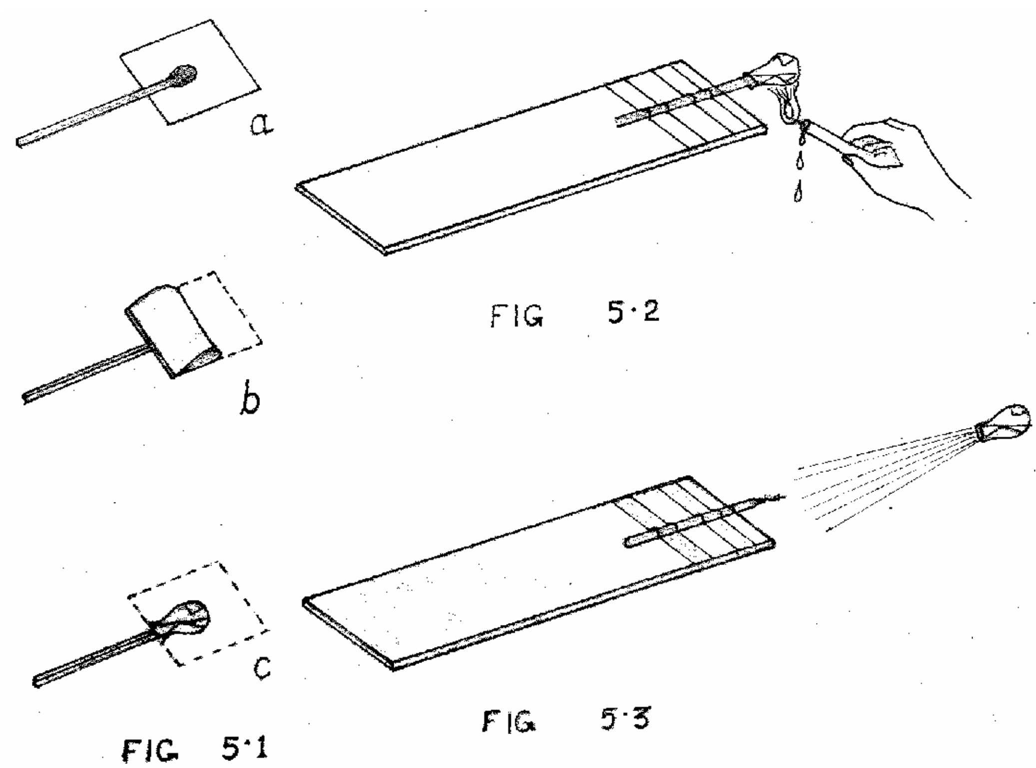
Box of matches

Aluminium foil (e.g. cigarette foil)*

Piece of glass

Cello tape

Candle



Fold a piece of foil about 1.5 cm x 2 cm over a match stick so as to form a *loose* cone over the match head. Make sure that there is an air channel running from the match head to the other end *(Fig 5.1 a, b,* c.)

Tape the match rocket to a piece of glass (your launching pad) so that it points to the air.

Hold a lighted candle (or match stick) under the head of the match stick enclosed in the foil (Fig 5.2).

In a short while the match head inside the foil will light up and you will hear the hissing sound of the gases coming out of the channel.

And off goes the foil like a rocket *(Fig* 5.3)!

Of course, you know why.

You can easily get a range of 40 to 50 cm. With practice, you can even go up to 100 cm.

*Aluminium foil from a medicine tablet card also works well.

6 Galileo was right

Materials

(A) Pair of scissors

Thick paper

Paper punch

Stapler

Two identical small things (coins, paper clips, washers, etc)

(B) Two identical marbles (or balls)

Table

Flexible plastic (or steel) ruler

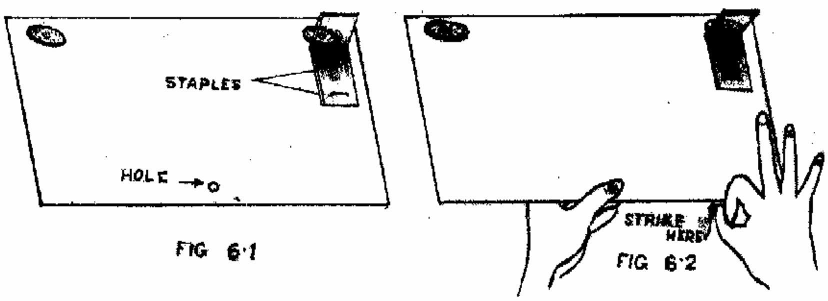


FIG 6·1

FIG 6·2

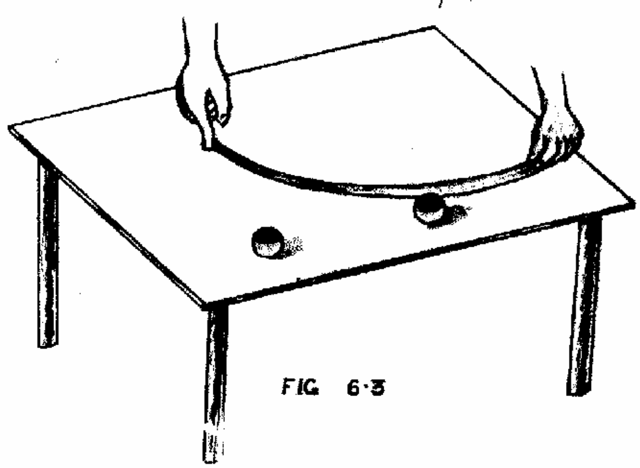


FIG 6·3

(A) Cut a card of thick paper about 12 cm x 8 cm. Punch a hole in the card close to the middle of one of the long sides.

Cut a 3 cm by 1 cm length of thick paper and bend it at right angles at I cm from one end. Staple it to the card as shown in Fig 6.1.

Place two identical small coins parallel to the other long side and symmetrical with respect to the small side of the card—one of the coins being in front of the bent piece *(fig 6.1)*.

Hold the card at the hole, between the thumb and forefinger of the left hand, so that it is horizontal.

Strike the card sharply with the index finger of the right hand *(Fig 6.2)*.

The coin in front of the bent piece will be pushed forward and pulled downward (by gravity). The other coin will be pulled straight down.

Listen carefully to the sounds the coins make as they hit the floor.

The two coins hit the floor at the same time.

Propelled and dropped objects seem to fall equally fast.

Galileo was right.

Repeat several times.

(B) Place two marbles near the edge of a table.

Hold one end of a plastic ruler firmly with the left hand and bend the other end back with the right hand *(Fig 6.3)*.

Release the scale from the right hand so that the marbles will be hit at the some t/me, but with different forces so that one will be propelled farther than the other.

Listen to the sounds when the two marbles hit the floor.

What do you find?

The two marbles hit the floor at the same time.

The difference in initial propulsion makes no difference.

Why?

7 Drinking Straw Balance

Materials

Sharp blade

Drinking straw

*Microscope cover slip**

Small screw to fit the straw

Paper pin (or sewing needle)

Rubber bands

*Microscope slides**

Empty match box (or any convenient box)

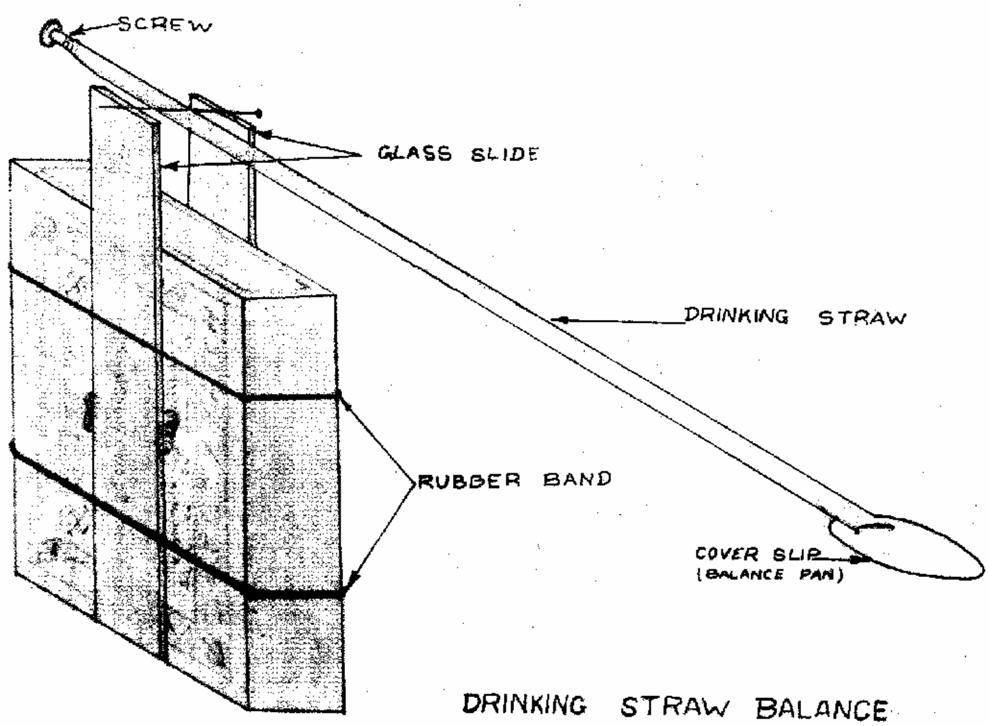


FIG 7

With a sharp blade cut a drinking straw to a length of about 15 cm. Cut a I cm silt across one end of the straw. Put a microscope cover slip into it. The straw will be the beam and the cover slip the *pan* of the balance.

Find a screw that will fit *snugly* into the other end of the straw. Turn it about three-fourths of its length into the straw. The screw will make its own threads into the straw.

Balance the straw on your finger. Pass a paper pin through the straw at the approximate balance point.

Use two rubber bands to secure two glass slides to a match box. Rest the pin of the drinking straw beam on the two edges of the slides *(Fig 7)*.

Adjust the screw in and out till the straw is horizontal.

The straw balance is now ready for use.

This straw balance is as sensitive as an analytical balance used by professional scientists. Even small air currents will cause it to move. Work away from air currents.

You have to compare the mass of an object to some selected unit mass. Use it to determine the mass of each component part of a flower thus:

Place a petal on the balance pan (cover slip). Turn the screw until the straw is horizontal. Remove the petal and substitute any convenient unit of mass (soy small paper punch circles) until the straw is again horizontal.

The number of circles gives the mass of the petal.

Similarly find the mass of sepals, leaves, etc.

Use your straw balance to weigh a number of objects. Use any convenient unit of mass.

*If you do not have microscope cover slip and slides, use a small circle/square of rather thick paper for the cover slip and two rectangular mirrors for the slides.

13

8 Balance a Pencil on its Point

Materials

Pencil

Thick wire (soy from a coat hanger)

Pair of pliers

Plasticine

Bottle with smooth cover

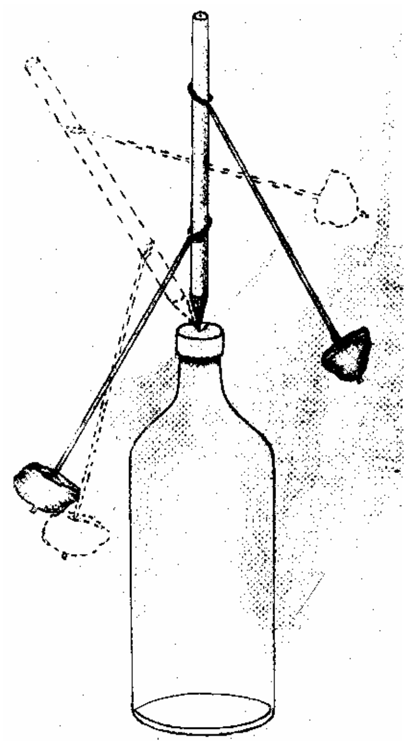


FIG 8

Balance a sharpened pencil by laying it across your finger. The balance point will be near the midpoint of the pencil.

Now try to balance the pencil on its point. It is just impossible. Why?

Next take two pieces of thick wire 15 to 20 cm long each. Using a pair of pliers bend one end of each to form a loop that will just pass over the pencil with a little force and stay on the pencil where you leave it.

Make two nearly equal lumps of plasticine. Load the unbent ends of the two wires with one lump each.

Pass the two wires over the pencil up to any two convenient positions. By trial and error adjust the positions and inclinations of the two wires so that the pencil *balances* on its point on, *say,* the top of the cover of a bottle.

You may have to try for some time before you succeed.

Tilt the pencil. It rocks here and there and finally comes back to the balanced position *(Fig 8).*

Why?

You can even spin the pencil on its point.

You may now hold the pencil on your finger tip and show the balancing trick to your friends.

9 Light Ruler balances Heavy Hammer

Materials

Ruler (say half metre stick)

Hammer

Wire Table

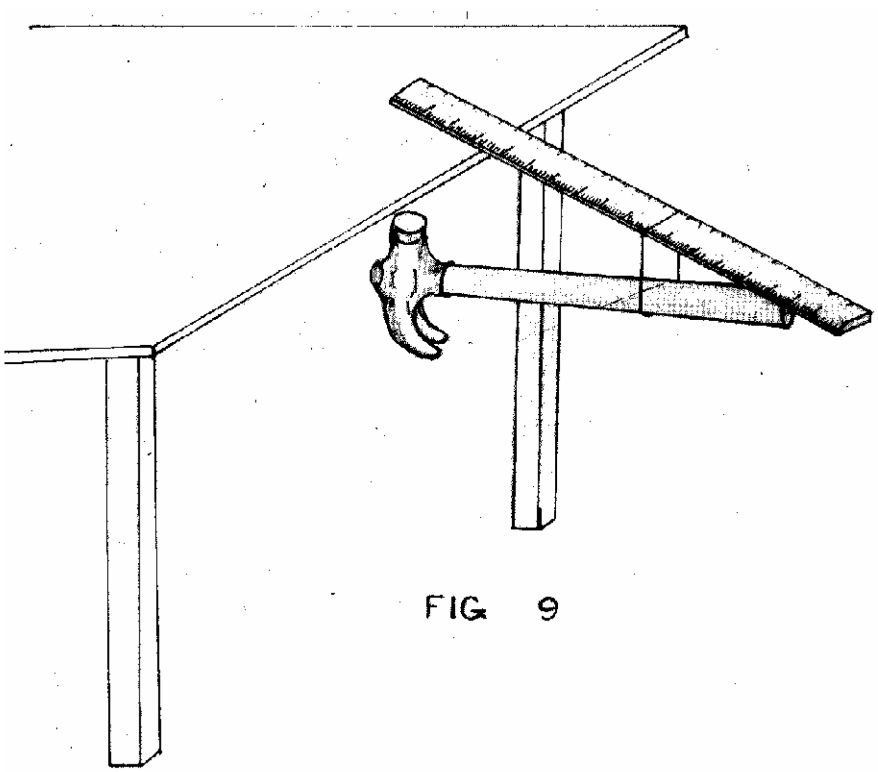


FIG 9

Take a half metre stick and a hammer. Make a loop of wire and pass it around the handle of the hammer and one end of the stick.

Place the other end of the ruler on the top of a table and near its edge such that the head of the hammer is under the table top* (Fig 9).

With a slight adjustment here and there, you will see that the heavy hammer and the light ruler balance.

Can you tell why?

Tilt the ruler a little and you can make the ruler hammer system rock around the balance point.

*Take care that the hammer does not slip out and hurt your foot.

10 Humpty-Dumpty refuses to fall

Materials

Fresh raw egg

Pin

Crayons

Pair of pliers

Wire

Candle

Small bowl of hot water

Small bowl of cold water

Brick

Take a fresh raw egg and with a pin, make a small hole at each of its ends.

Empty the egg by blowing hard at one end. The contents will come out at the other end *(Fig 10.1)*.

With crayons, draw a face of Humpty Dumpty on the egg shell.

With a pair of pliers, cut a length of wire into small bits. One by one, put the wire bits into the egg shell till the shell feels fairly heavy *(Fig 10.2)*.

Now pour some molten wax through the hole into the shell and then close the hole with wax from a candle *(Fig 10.3)*.

Hold the shell *vertically* first in a bowl of hot water and then in a bowl of cold water. This makes the wax (inside the shed) solidify and the wire bits are held in position.

Keep Humpty Dumpty near the edge of a brick (wall).

Gently tilt Humpty Dumpty till it is almost horizontal and leave it. It peeps over the edge of the brick without falling off and quickly becomes vertical again *(Fig 10.4)*.

Why does Humpty Dumpty refuse to fall?

11 Double Cone rolls up

Materials

Two large funnels of the same size (plastic, glass or steel)

Two scales (metre sticks)

Adhesive tape

Book (or any object) about 2-3 cm thick

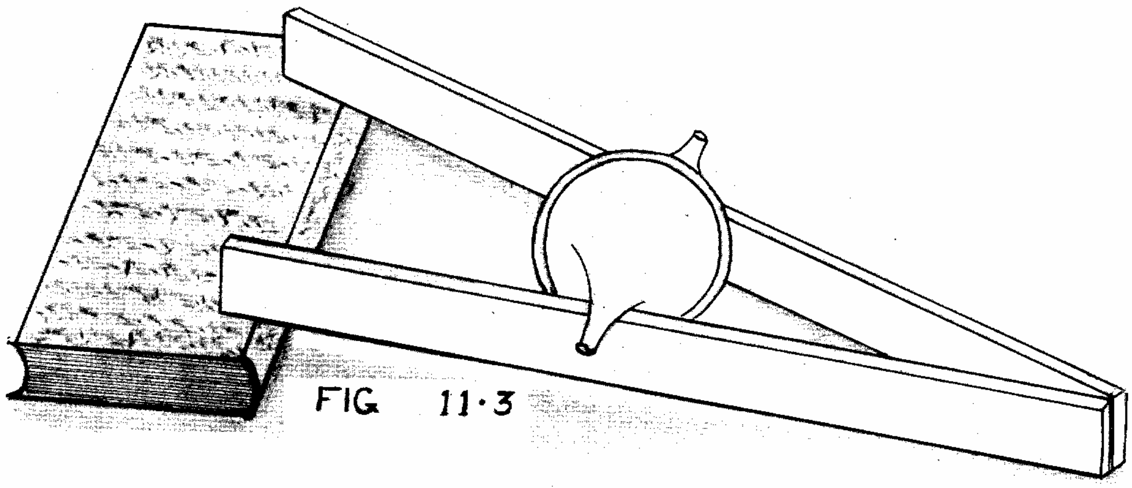


FIG 11·3

Tape two funnels of the same size together at their mouth so as to form a *Double Cone (Fig 11.1)*.

The CG of the double cone is shown in *Fig11.2a* (side view) and *fig 11.2b* (front view).

Tape two metre sticks together at one end and spread them apart at the other end. Keep a book under the open end of the sticks so as to form a low inclined railing.

Place the double cone near the mid-point of the railing and let go *(Fig 11.3)*.

Do you expect the double cone to go up or down?

What do you see?

The double cone will roll uphill towards the book.

Why?

Do the cones defy the law of gravity?

12 Leaning Tower Model

Materials

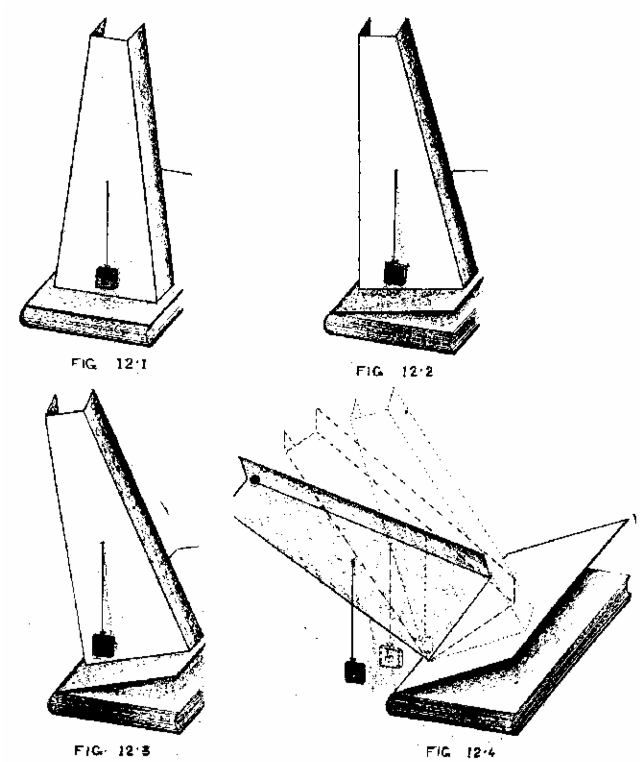
Cardboard

Pair of Scissors

String

Weight (washer, nut, stone, lump of clay, etc)

Book with hard cover



Cut out from cardboard a shape resembling a tower, such that you can fold the sides at right angles and the tower can stand upright with its base on a flat surface (Fig *12.1)*.

Locate the CG of the shape as in Activity 9, Book 4.

Tie a small weight to one end of a length of string. Pass the other end through a hole made at the CG. Adjust the length of the string so that the weight hangs just above the base of the tower.

Keep the tower (along with the weighted string) on the hard cover of a book. The weight will now be just above the book *(Fig 12.1)*.

Raise the cover of the book *very slowly.* Watch carefully what happens to the weight. Continue raising and watching. What do you find?

As long as the weight is within the base of the tower, the tower does not fall though it is very much leaning towards one side *(Figs 12.2, 12.3)*.

Why?

As soon as the weight goes outside the base, the tower topples down *(Fig 12.4)*. Repeat several times.

Can you now explain why the tower of Pisa built almost four hundred years ago (and leaning more and more every year) does not fall? Will it ever fall?

13 Demonstration of Weightlessness

Materials

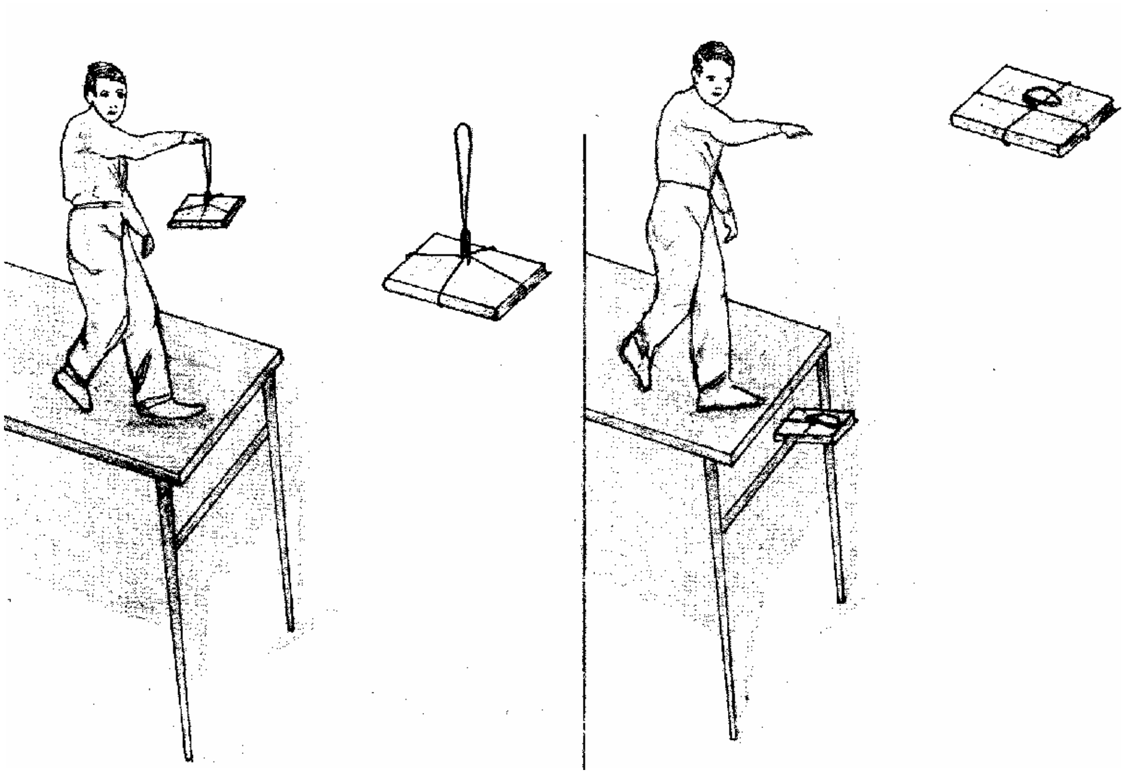
Book

String

Paper clip

Rubber band

Table



Tie a length of string around a book. Let the free end of the string be tied to a paper clip.

Pass a rubber band through the paper clip and hold the book by the rubber band. What do you see? The rubber band is stretched. Why?

Repeat with different books. What happens? The heavier the book, the more the rubber band is stretched.

Now stand on a table and hold the book suspended by the rubber band as high as you can *(Fig 13.1).*

Let go.

Observe *closely* if the rubber band remains stretched as the book falls.

What do you find?

It does not (Fig *13.2).*

Are you surprised?

What happens to the weight of the book?

Repeat for all the books.

14 Label the Lever

Materials

Wheelbarrow

Sugar tongs

Pair of scissors

Air bellows

Paper cutter

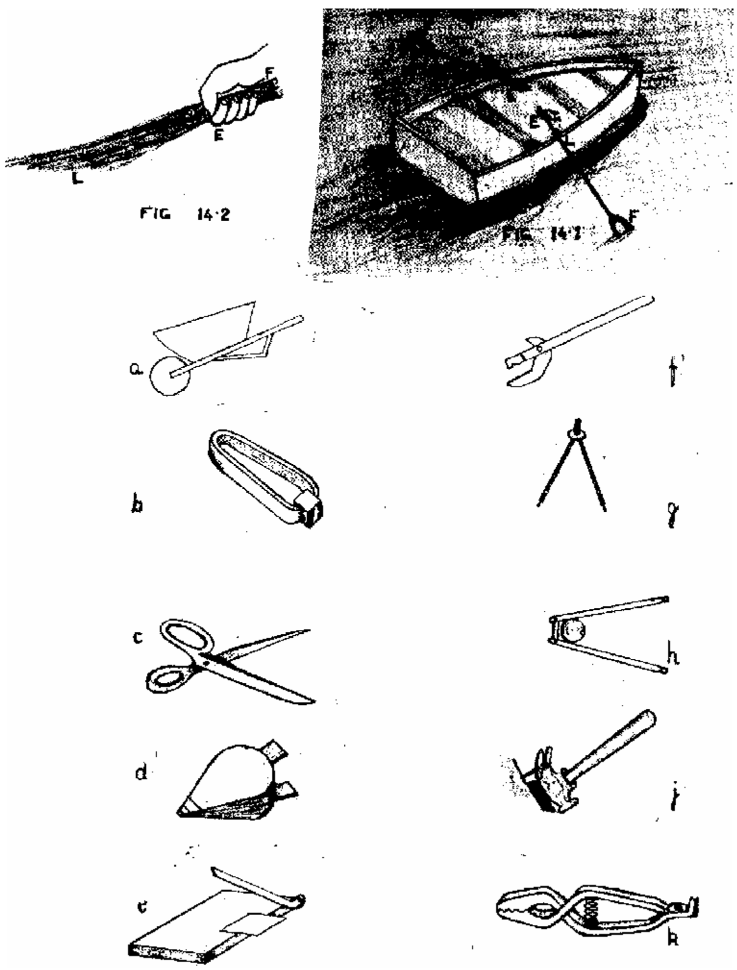
Tin opener

Pair of compasses

Nut cracker

Claw hammer

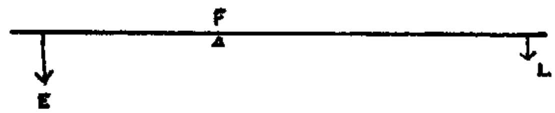
Crocodile clip



In Activity No. 12 Book 4, you have found out the Law of Levers: The product of effort and effort-arm is the same as the product of load and load-arm.

There are three types of levers, depending on the relative positions of the effort (E), fulcrum (F) and load (L).

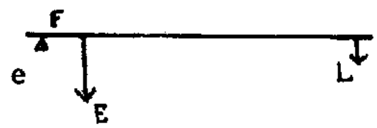
The first-class lever has F between E and L *e.g.* balance and see-saw.



The second-class lever has L between F and E e.g. while rowing a boat the ends of

The oars are points where the effort is applied, the row-locks are points where the load is and the pivotal points of the oars (the ends in water) are the fulcrum *(Fig 14.1).*

The third-class lever has E between F and L e.g. while sweeping, the end of the broom nearest you is the fulcrum, the force which you apply near the fulcrum is the effort and the load is at the far end of the broom *(Fig 14.2).*



Label the levers shown in Fig 14.3 explaining how you classify them in the three types. Work with as many actual pieces as possible.

15 Convection Box

Materials

Empty shoe box

Pair of sharp scissors

Thick paper

Cello tape

Two glass tubes

Transparent paper (soy cellophane paper)

Short candle

Source of smoke (soy agarbati, burning rag, cigarette, etc)

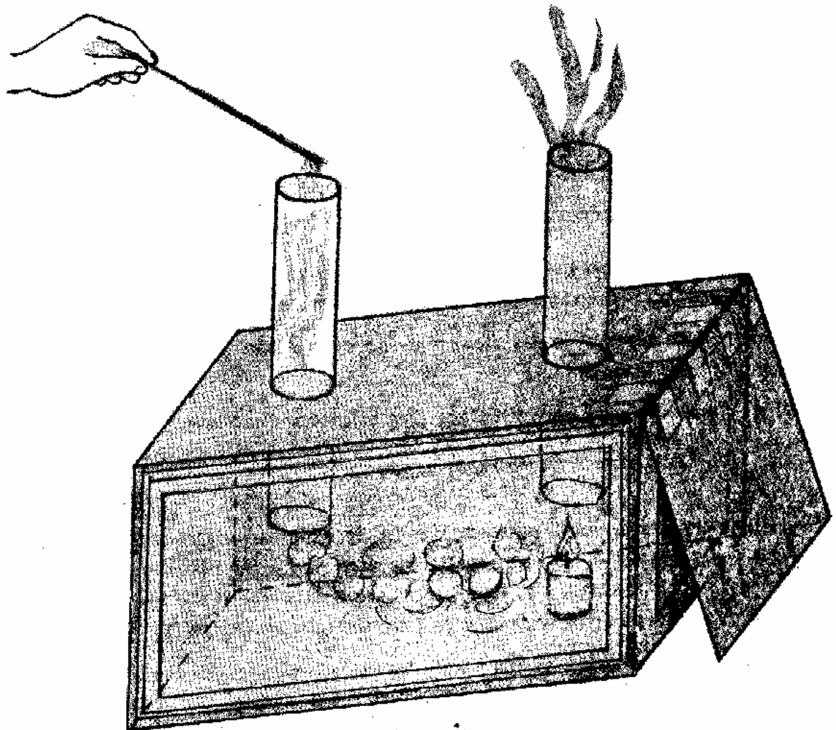


FIG 15

Remove the cover of a shoe box. Cut out centrally, three fourths of one of the smaller sides. Tape one edge of a piece of thick paper to this side so as to make a hinged door that can cover up the opening completely.

Take two glass tubes about 2 cm in diameter and open at both the ends. Cut out two holes, in one of the larger sides, somewhat smaller than the opening of the tubes.

Use cello tape to cover the top of the box with *transparent* paper. Push the glass tubes into the holes.

Place the box on the other long side. Light a short candle and through the hinged door place it on the box directly under one of the tubes.

Hold a smoke source near the other tube (under which there is no candle). What do you observe?

The smoke moving through the box traces the path of the current of air. You will be able to see the smoke being carried *down* the tube, across the box and *up* the other tube *(Fig 15).*

Try to think out how this happens.

This activity also demonstrates how winds are caused. Find out the similarity between the two.

16 Boil Water in a Paper Pan

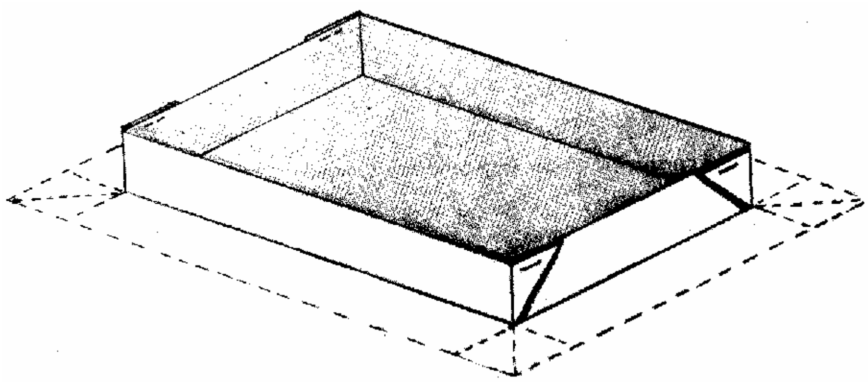
Materials

Thick paper

Stapler

Kerosene stove

Wire gauze



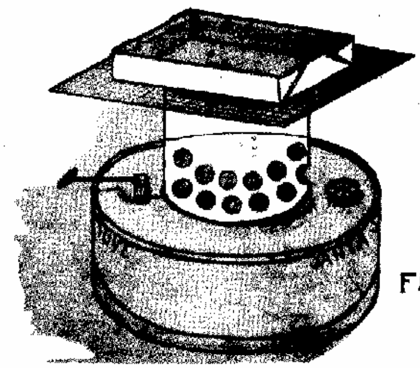


FIG. 16·2

Make two identical paper pans from thick paper. Staple the folded corners nicely *(Fig 16.1)*.

Light a kerosene stove and keep wire gauze over it.

Put water in one of the pans and place it on the gauze.

Wait for some time and observe what happens.

The water in the paper pan boils without the paper catching fire *(Fig 16.2)*.

Are you surprised?

Do you know the reason why this happens?

Now place the other pan empty on the wire gauze.

What happens?

The pan burns.

Why?

You could fry *pakodas* in a paper *kadai* by filling the pan with oil instead of water.

17 Tricks with Ice

Materials

Ice

Water

String

Salt

Piece of cloth

Two bricks

Thin wire

Two heavy weights (say bags of stone)

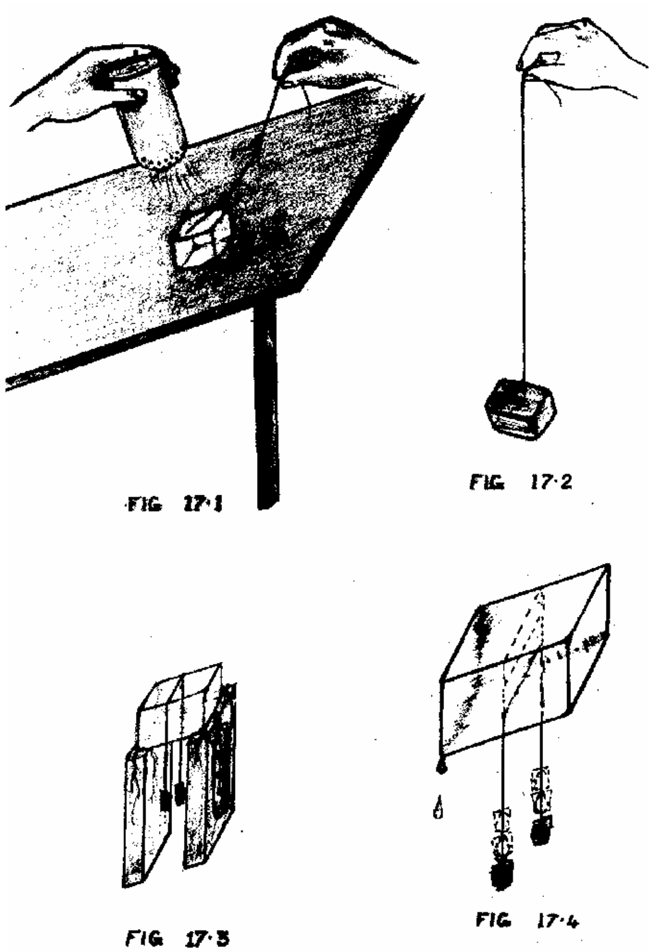


FIG 17·1 FIG 17·2 FIG 17·3 FIG 17·4

1 *String lifts ice*

Take an ice cube or choose a piece of ice with a fairly flat surface.

Dip a length of string in water till it is thoroughly wet and place a part of it over the surface of ice.

Sprinkle some salt along the line and the sides of the string *(Fig 17.1).*

Wait for a couple of minutes.

Hold the free length of the string in your hand.

What do you see?

The string is frozen to the ice and you can lift the ice with the string *(Fig 17.2).*

Do you know why?

2 Make an ice ball

Hold small pieces of ice in a piece of cloth and press them together between the palms of your hands for a few minutes. Take away your hands. What happens? The pieces join together and form a ball. Why?

3 Wire cuts through ice without breaking it

Tie two heavy weights, soy bags filled with stone, one to each end of a length of wire.

Keep a block of ice on the top of two bricks placed 2-3 cm apart.

Hang the wire along with the stones over the block of ice *(Fig 17.3).*

What do you see?

The wire cuts through the ice but the block of ice does not break *(Fig 17.4).*

Find out why this happens.

18 Home Made Stethoscope

Materials

Rubber (or plastic) tubing

Three medium size plastic (or glass) funnels

'Y' tube (glass, plastic, metal)

Thin wire (or string)

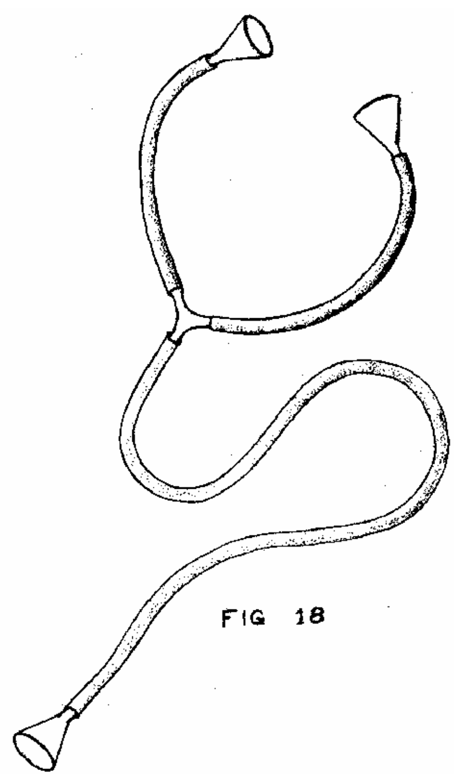


FIG 18

Cut two pieces of rubber tubing each about 20 cm long and a third piece 40 to 50 cm long.

Fix a funnel to one end of each of the three tubes.

Join the free ends of the equal rubber tubes to the two arms of a 'Y' tube and the free end of the third tube to the leg of the joint.

Use wire (or string) to make all the connections tight. The stethoscope is ready (Fig *18),*

Hold the funnels from the short equal tubes near your two ears (ear-pieces) and hold the third funnel on the chest of a friend.

What do you hear?

You can hear the beating of his heart. How many beats per minute?

How does this stethoscope work?

Compare the heart beat of your friend before and after he has run a little.

What do you find?

The heart beats much faster after exercise.

Why?

The doctor's stethoscope works exactly in the same way.

19 Invisible Pin

Materials

Cork (or opaque plastic) sheet*

Pin

Basin

Water

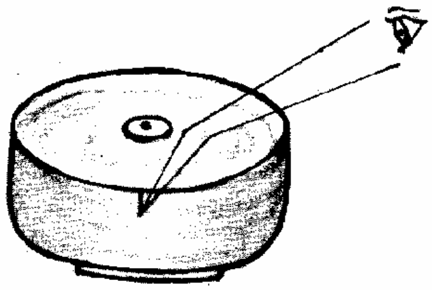


FIG 19·1

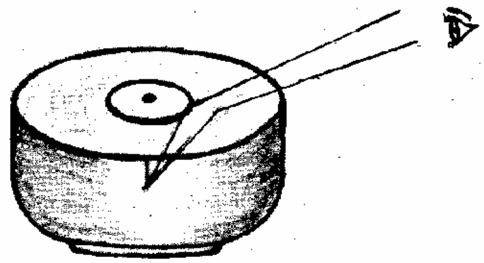


FIG 19·2

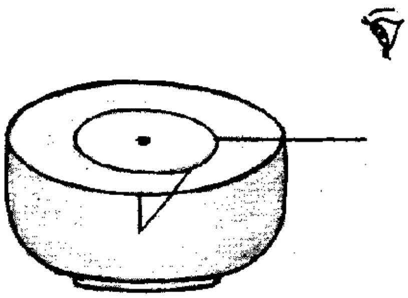


FIG 19·3

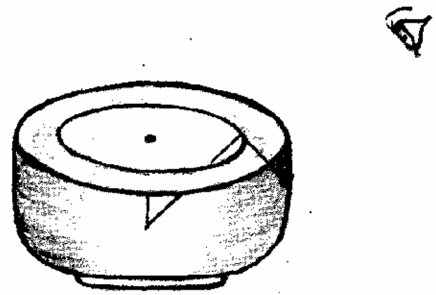


FIG 19·4

Cut circular discs from cork or plastic sheet, 4 cm, 5 cm, 6 cm, 7 cm in diameter. Push an ordinary pin into the centre of each disc.

One by one float the discs (with the pin inside the water) in a large basin of water.

What do you observe?

With smaller discs you can see the pin *(Figs 19.1, 19.2).*

As you use discs of larger and larger diameter, a stage comes when however you bend your head, you cannot see the pin though it is long enough for the cork not to hide it.

The pin becomes *Invisible (Figs* /9.3, *19.4).*

Why do the rays from the pin fall to reach your eye?

*Covers of plastic jar work well.

20 Portable Water Drop Microscope

Materials

*Aluminium foil (or thick paper)**

Pair of scissors

Black paint

Two match boxes

Rubber bands

Vaseline

Water

Small objects

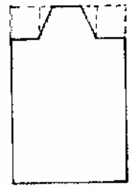


FIG 20·1

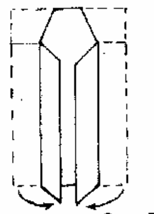


FIG 20·2

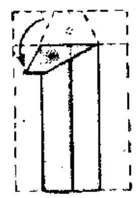


FIG 20·3

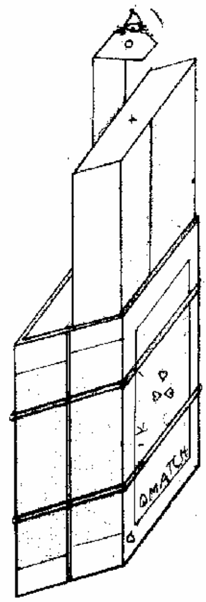


FIG 20·4

Cut out a piece of aluminium foil 6 cm x 8 cm. Cut off 1.5 cm square at each of the corners on one small side. Cut off symmetrically corners on either side of the centre piece *(Fig 20.1*).

Fold the foil piece along its length, at- 1.5 cm from either end, to be flat with the surface *(Fig 20.2).*

Bend the projecting part to be at right angles to the length. This is the nose of the microscope.

Make a circular hole in the nose and paint it black around the opening *(Fig 20.3).*

Choose two match boxes with well fitting drawers. Push the long end of the folded piece between the drawer and the back of one match box. Secure the match boxes with two rubber bands.

Rub Vaseline around the hole both on the top and the bottom (no Vaseline in the hole). Put a drop of water to fill the hole and hang down under it. This drop is the lens of the microscope.

The side of the drawer *directly facing the nose* is the object *stage.*

The magnifier is now ready for use.

Put any small thing on the object stage *say* a pin, a match, dirt, sand, chalk, pollen, etc. Make sure that the object is well illuminated.

Put your eye above and close to the lens and look through it.

Move the object-stage drawer up and down until you see the object clearly *(Fig 20.4).*

When you see the object clearly, it is said to be in focus. You will see the object much bigger i.e. *magnified.*

Try drops of different sizes and note the difference in magnification.

Let the microscope be your constant companion. You have the mini-world at your command. See it anytime you like with your microscope.

*Foil from inside cover of a tin works well. Thick paper also works well.

**To make a drop flatter; touch gently a match to the bottom of the drop. To make the drop rounder, dip a match in water and then touch it to the top of the drop.

21 HOME-MADE Rainbow

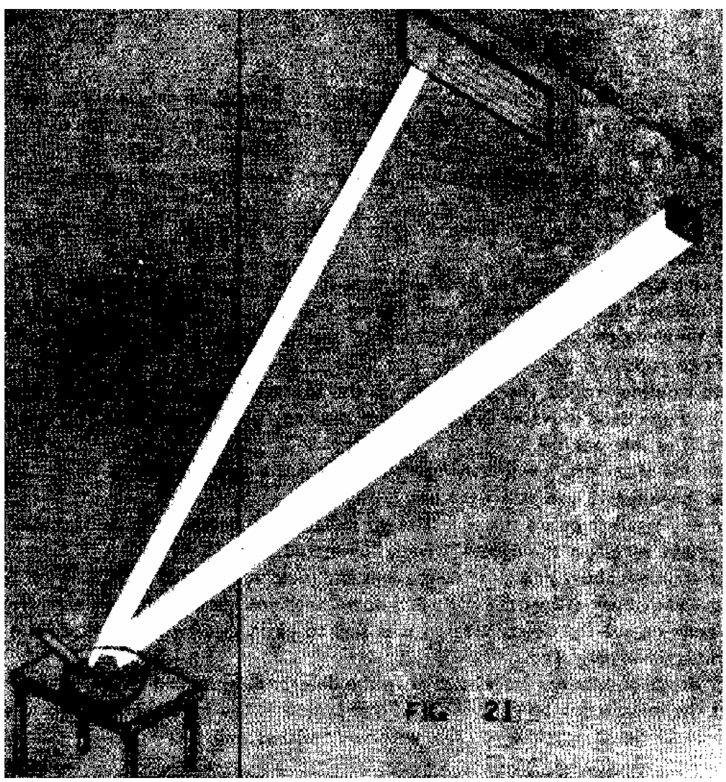
Materials

Dish

Water

Plane mirror

Sunlight (slanting)



Pour some water in a dish.

Keep it on a table or window sill or ground where you get slanting sunlight (morning or late afternoon). Adjust so that the dish is in the beam of sunlight.

Hold a plane mirror in the water against the edge of the dish. Get a reflection of the sunlight on a wall or a piece of paper.

Change the inclination of the mirror

For some positions of the mirror, the reflected sunlight will have all the rainbow colours *(Fig 21)*.

You have a home-made rainbow.

Can you find out the prism that gives this rainbow?

Stir the water slightly and observe what happens.

White light appears on the wall.

Can you explain why?

Allow the water to become still and colours reappear again.

22 Coloured Brushes with White Light

Materials

Flashlight

Table

Fine wire mesh

Piece of cotton cloth (say handkerchief)

Piece of nylon

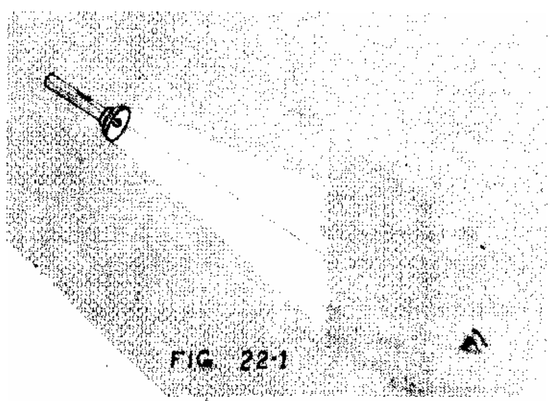


FIG. 22·1

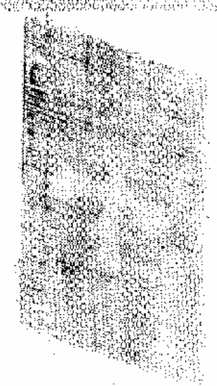


FIG 22·2

Work at night or darken a room if it is daytime. Switch on a flashlight and place it on a table.

Stand far away from the light and look at it through a fine wire mesh (Fig *22.1).* What a beautiful sight!

You see a bright cross of coloured brushes *(Fig 22.2*). Take away the mesh and you see only a single light. Repeat with a cloth handkerchief and a piece of nylon. Look at any distant light e.g. street light, car light, etc through a handkerchief.

Look at the moon through a piece of cloth.

Every time you get beautifully coloured brushes although the source of light is white. Rotate the mesh (wire, cloth) and the brush pattern also rotates. Find out why this happens.

23 Optical Illusions—I

Materials

Plain paper

Tracing paper

Pencil

Pair of compasses

Protractor

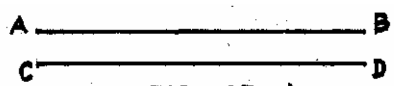


FIG 23·1a

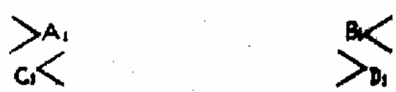


FIG 23·1b

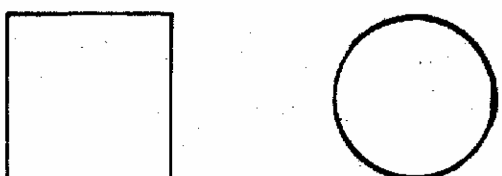


FIG 23·2a

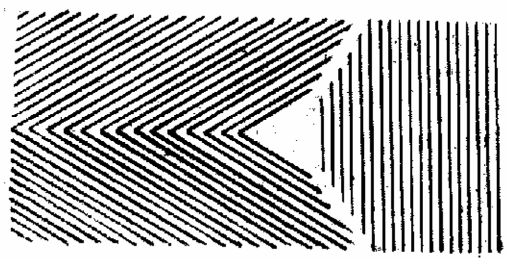


FIG 23·2b

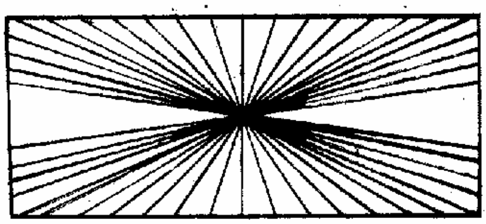


FIG 23·3a

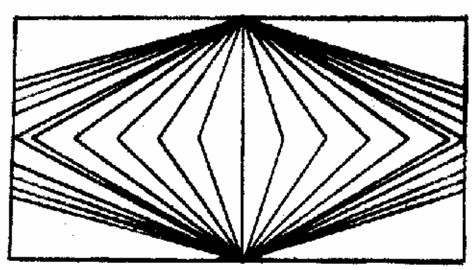


FIG 23·3b

Usually we believe what we see with our own eyes. However, our sense of sight, at times, can fool us. Such an experience is called an *illusion.*

Here are some interesting and amusing optical illusions.

(i) AB and CD are two equal and parallel lines *(Fig 23.1a).* Check this for yourself.

On a piece of tracing paper, mark points A_1, B_1 C_1 D_1 exactly over A, B, C, D. At A_1 and B_1 draw two equal angles pointing outwards. At C_1 and D_1 draw two equal angles pointing inwards *(Fig 23.1 b).*

Place the tracing paper so that A_1 lies on A, B_1 on B and so on. Look at the lines through the tracing paper.

What do you see?

Although the lengths of AB and CD are the same, through the tracing paper AB Jocks longer than CD.

The oppositely directed angles seem to play some trick,

(ii) Trace the square and circle In Fig 23.2a on a tracing paper.

Place the square on the line pattern Fig 23.2b. Repeat with the circle.

What do you see?

The square and the circle look distorted.

(iii) Draw two parallel lines on tracing paper.

Place the parallel lines on Fig 23.3a and see the lines against the pattern.

The lines seem to bulge out.

Next see the parallel lines against the pattern on Fig 23.3b.

The lines now seem to bend inwards.

What do you conclude?

Can you always trust your own eyes?

24 Optical Illusions—II

Materials

Thick paper

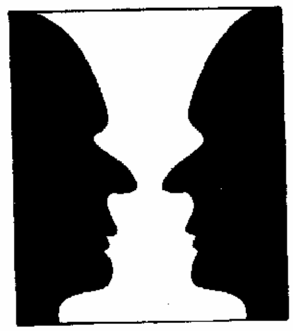
Tracing paper

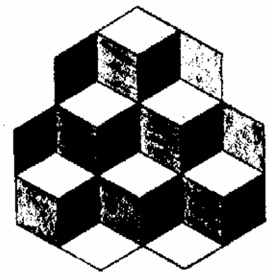
Drawing pencil

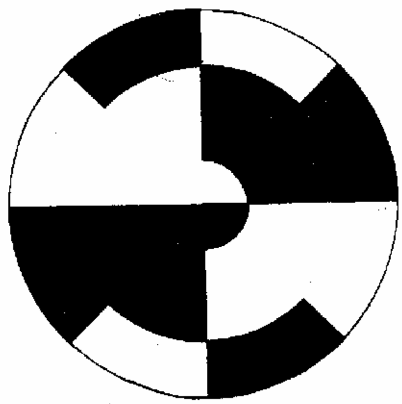
Black poster colour

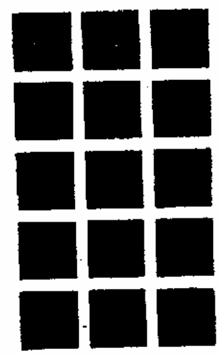
Ordinary wooden spinning top

Bright source of light









Here are a few more optical illusions.

(i) Stare at the drawing of the pile of cubes in Fig 24.1.

After you stare at it for a few seconds, count the number of cubes. How many are there? Six or seven?

Sometimes the white surfaces will look like the top of the cubes and the number of cubes is six. The picture will suddenly seem to change and you will see the white surfaces as the bottom of the cubes and their number is seven.

Why does this happen?

(ii) Does the drawing in Fig 24.2 look like that of a white vase on a black background or two black profiles on a white background?

Stare at the drawing for several minutes. The picture changes from vase to profile and profile to vase and so on.

(iii) Stare at the drawing of Fig 24.3. You will see grey patches where the white lines cross.

(iv) Copy the black and white circular design of Fig 24.4 on a circular disc of thick paper of radius 5 cm. Use poster colours or black ink to blacken the relevant parts.

Make a hole at the centre of the disc and fix it to the rod of a spinning top with the design side facing upwards, Illuminate the disc well preferably under a tube tight.

Spin the top. What do you see?

Although the disc is black and white, you will see colours if you stare at it while it spins. The longer you stare the more colours you see.

Try and make another type of black and white design that will give the same type of illusion.

26 Electrophorus

Materials

Candles

Box of matches

Aluminium dish (ordinary thali will do)

Perspex (or plastic) sheet

Piece of cloth (or paper)

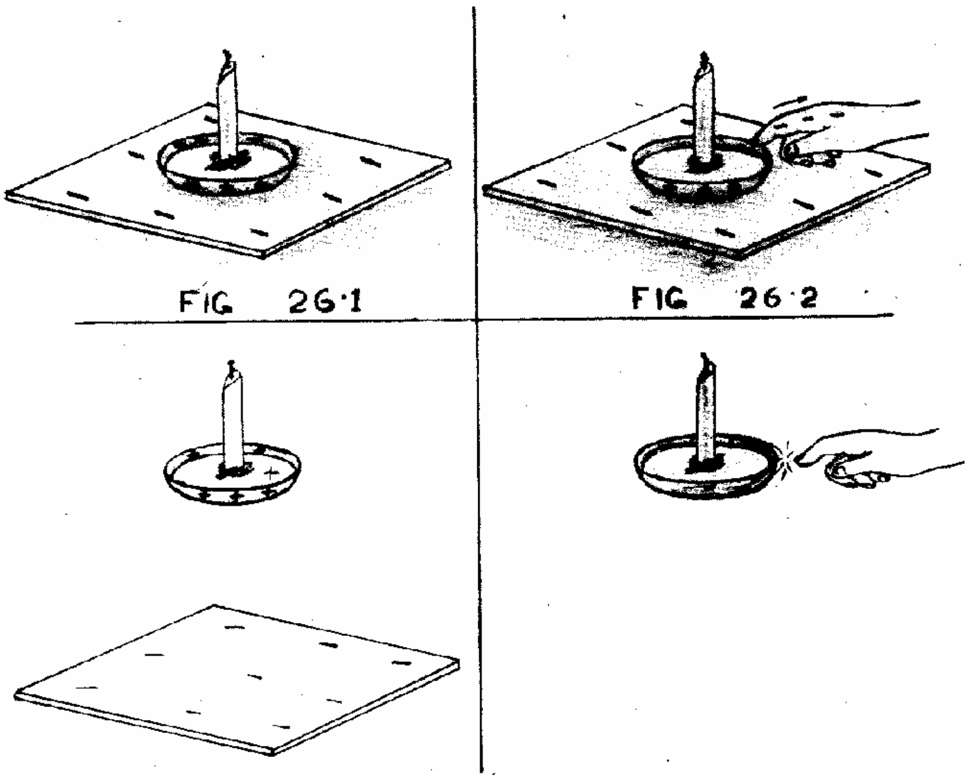


FIG 26·1

FIG 26·2

Pour some molten candle wax in the centre of an aluminium dish. Press a candle, bottom down, in the molten wax. Hold it straight until the soft wax hardens. The candle will be the *insulating handle.*

The electrophorus is ready.

Keep a Perspex sheet on a table and rub it 25 to 30 times with a piece of cloth-Press hard as you rub. Hold the aluminium dish by the insulating handle and place it on the sheet *(Fig 26.1).*

Touch the edge of the dish with your finger *(Fig 26.2).*

Lift the dish by the insulating handle *(Fig 26.3).*

The electrophorus is charged.*

Tell your friend to bring his finger *near* the electrophorus and watch what happens.

A spark jumps between his finger and the dish *(Fig 26.4).*

The electrophorus is discharged.

Do you know why?

Charge the electrophorus again and bring it *close* to a metal object, *say* a water tap, a door knob. Again you get a spark and the electrophorus is discharged.

Every time you want to charge the electrophorus, place the dish on the Perspex sheet, touch the rim and lift the dish by the insulating handle. It is not necessary to rub the Perspex sheet every time.

Use your electrophorus whenever you need a positively charged body.

Bring two charged electrophorus dishes near to one another and then in contact.

What do you observe?

Explain your observation.

*Do this activity on a cold dry day.

27 Aluminium-leaf Electroscope*

Materials

Glass (or transparent plastic) jar

Plastic sheet

Aluminium clothes-line clip

Aluminium foil (from chocolate or cigarette wrapper)

FIG 27·1

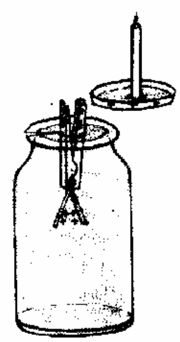


FIG 27·2

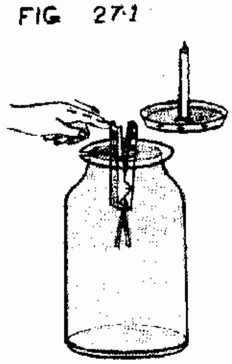


FIG 27·3

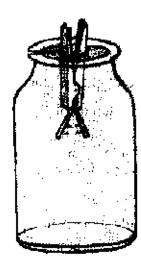


FIG 27·4

Take a glass jar without cover. Out of plastic sheet cut a circular piece that will cover the bottle well.

At the centre of the circle, make a hole that will just hold an aluminium clothes line clip. Cut a slot along one of the radii from the hole to one edge. The clip can now be passed through the slot and held in the hole.

Cut a strip about I cm wide and 5 cm long from an aluminium cigarette wrapper foil. Fold the foil in half and slip it between the jaws of the clip. Place the clip in position in the hole in the cover. Place the cover on the jar *(Fig 27.1)*.

The aluminium-leaf electroscope is ready.

Bring any charged body say a charged electrophorus (Activity 26) near the metal clip and observe what happens.

The leaves spread apart *(Fig 27.2)*.

With the electrophorus in position, touch the clip with your finger. The leaves collapse (come nearer) *(Fig 27.3)*.

Remove the *finger first* and then take away the electrophorus.

What happens?

The leaves diverge again. The electroscope is *negatively* charged *(Fig 27.4)*.

Try to explain how this happens.

Bring a negatively charged body (soy, a comb rubbed with paper) near the clip and the divergence increases.

Bring a positively charged body (say, a glass test tube rubbed with silk) near the clip and the divergence decreases.

The electroscope is thus a charge detector.

Think out how you would charge the electroscope with a positive charge.

*This activity works well on a cold, dry day.

**Thick paper also works well.

28 Electron Ferry

Materials

Candle wax

Aluminium pan

Two empty tins

Aluminium foil

Sewing thread

Pencil

Brick

Perspex sheet

Piece of cloth (or paper)

Electrophorus

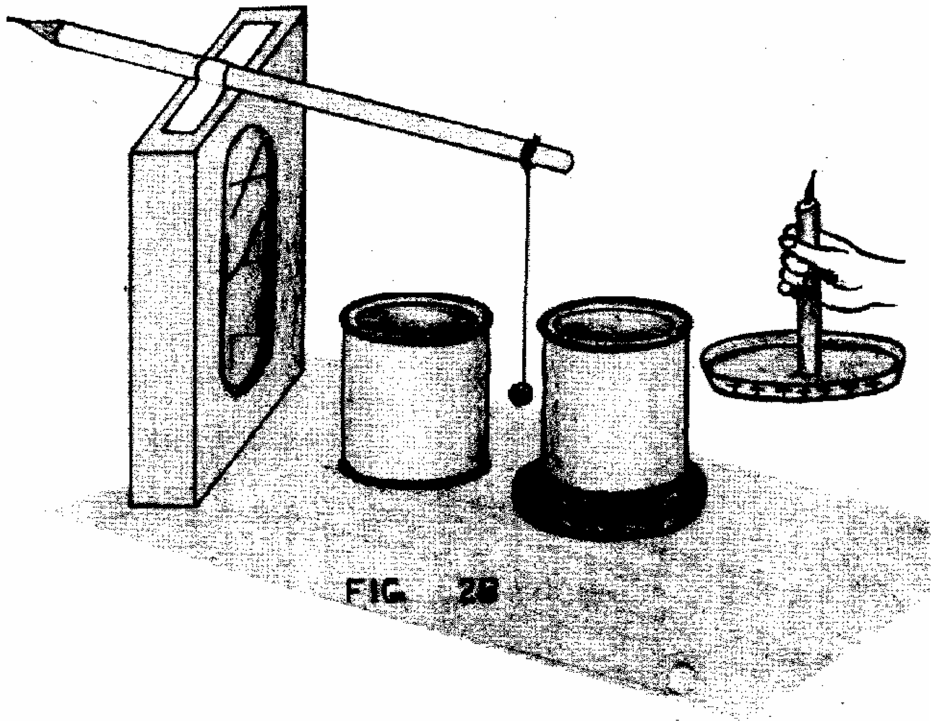


FIG. 28

Melt some candle wax* and pour it in an aluminium pan to a depth of about 2 cm. Allow the wax to cool. You get a disc of wax.

Keep two empty tins a few centimetres apart one on the wax disc and the other on the table.

Press some aluminium foil to form a small ball at one end of a piece of thread. Tie the other end of the thread near the end of a long pencil.

Tape the pencil on a brick such that the aluminium ball lies symmetrically between the two tins.

Bring a charged electrophorus (Activity 26) near to tin 1 (on wax disc) and observe what happens *(Fig 28)*.

The aluminium ball moves back and forth rapidly between the two tins striking each tin alternately!

Why?

Take the electrophorus away and see what happens.

The ball vibrates for some more time and finally comes to rest.

When the ball is moving, touch the tin 1 with your finger. What happens?

The ball immediately stops moving.

Why?

What is the purpose of the wax disc?

*You can collect wax that falls from burning candles.

** If the bail docs not vibrate, bring the tins

29 Flame controls the Brightness of the Bulb

Materials

Thin iron wire

Pencil

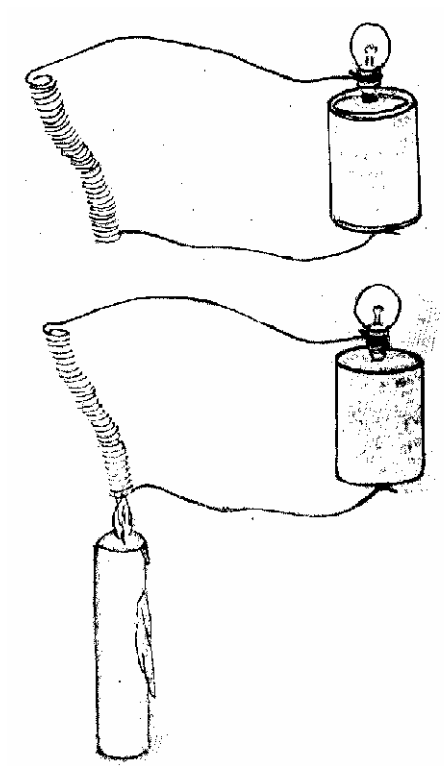
Cello tape

Dry cell

Flashlight bulb

Candle

Box of matches



Cut about 50 cm of thin Iron wire. Wind it tightly around a pencil. Take out the pencil and you have a coil of wire.

Tape one end of the coil to the bottom of a dry cell and twist the other end around the grooves of a flashlight bulb.

Press the base of the bulb on the top of the cell. The bulb lights up *(Fig 29.1).* Hold the bulb in this position and heat the coil in the flame of a candle.

Wait and watch what happens.

The bulb slowly becomes dimmer and dimmer and may almost go out *(Fig 29.2*).

Why?

Take the coil out of the flame. The bulb gradually brightens up again.

30 Sucking Coil

Materials

Enamelled copper wire

Tube of glass (or plastic or cardboard)

Cello tape (or rubber band)

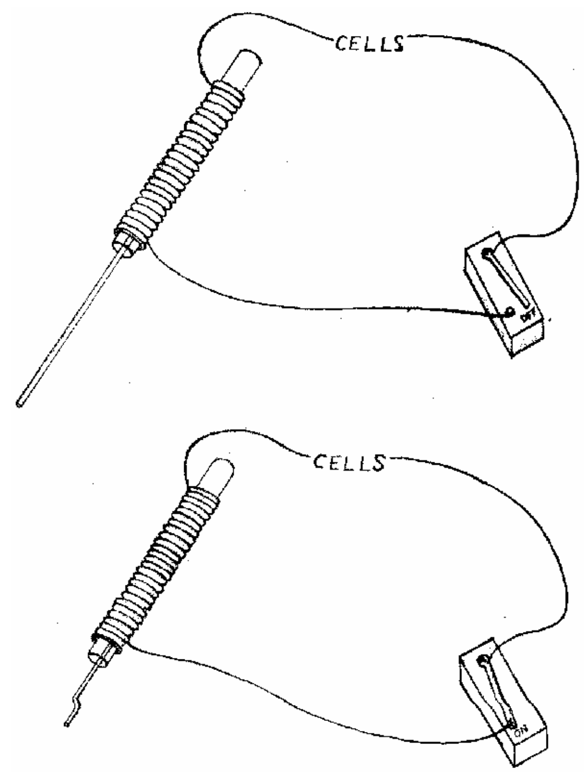
Sand paper

Two dry cells

Tap key

Connection wires

Stiff steel wire (say from a paper clip)



Leave about 25 cm of enamelled copper wire free and begin winding the wire on a tube. Work slowly and carefully. When you have wound about 3-4 cm length of the tube, start a second layer of wire over the first and complete the second layer. And now wind a third layer.

Use cello tape or rubber band to keep the wire in place.

Remove the insulation from each end of the wire by rubbing with sand paper.

Connect the coil of wire through a tap key to the two dry cells.

Drop a small piece of stiff steel wire* about 3-4 cm long into the tube. Hold the tube in such a way that the wire is only partly inside the tube *(Fig 30.1)*.

Press the key and observe what happens.

The steel wire is sucked into the coil *(Fig 30.2)*.

Release the key.

The wire drops down.

Repeat and make the wire move up and down and click on the table every time you open the switch.

You have a sucking coil.

Try to explain why a current in the coil is able to suck the wire into the tube.

*Half the length of an ordinary paper clip (straightened out) works well,

31 Morse Key and Sounder and Model Telegraph Set

Materials

Shears (tin scissors)

Old tin

Sand paper

Plywood

Handsaw

Drawing pins

Soft iron nail (about 5-6 cm long)*

Enamelled copper wire

Connection wires

Cello tape

High amperage dry cell (or battery)

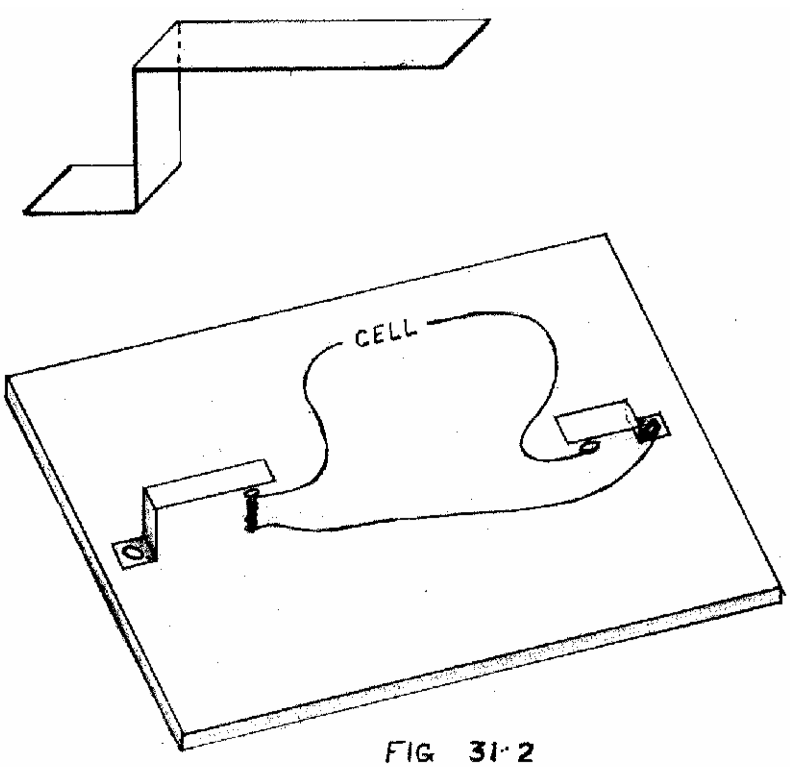


FIG 31·2

With a pair of shears, from an old tin cut out two strips, 1 cm wide each and 18 cm and 8 cm long respectively. Sand paper the strips to remove the paint, if any.

Bend the long strip at 2 cm and 8 cm from one end so as to form a long right angle step *(Fig 31.1).* This is the sounder strip.

Bend the short strip at 2 cm and 3 cm from one end to form a short right angle step. This is the *key strip.*

Use a handsaw to cut a plywood board 20 cm x 8 cm.

Fix the sounder strip and the key strip to the board with drawing pins (or short nails).

Leaving about !5 cm at either end, wind three to four layers of enamelled copper wire around a 5 cm nail of soft iron. Use cello tape to keep the layers in place. Remove the insulation from the ends of the wire.

Fix the wired nail to the board so that the head of the nail is just under the end of the sounder strip. Fix a drawing pin (on the board) under the free end of the key strip. The key strip with the drawing pin is the top key.

*Heat an ordinary nail to red heat in coal fire at night, leave it there over-night and take it out in the morning.

Connect the free ends of the wire to a dry cell battery through the tap key°(*Fig31.2*).

Morse key and sounder is ready.

Press the tap key. The sounder strip clicks against the nail^{+}.

Release the key and the sounder strip is released.

You know why this happens.

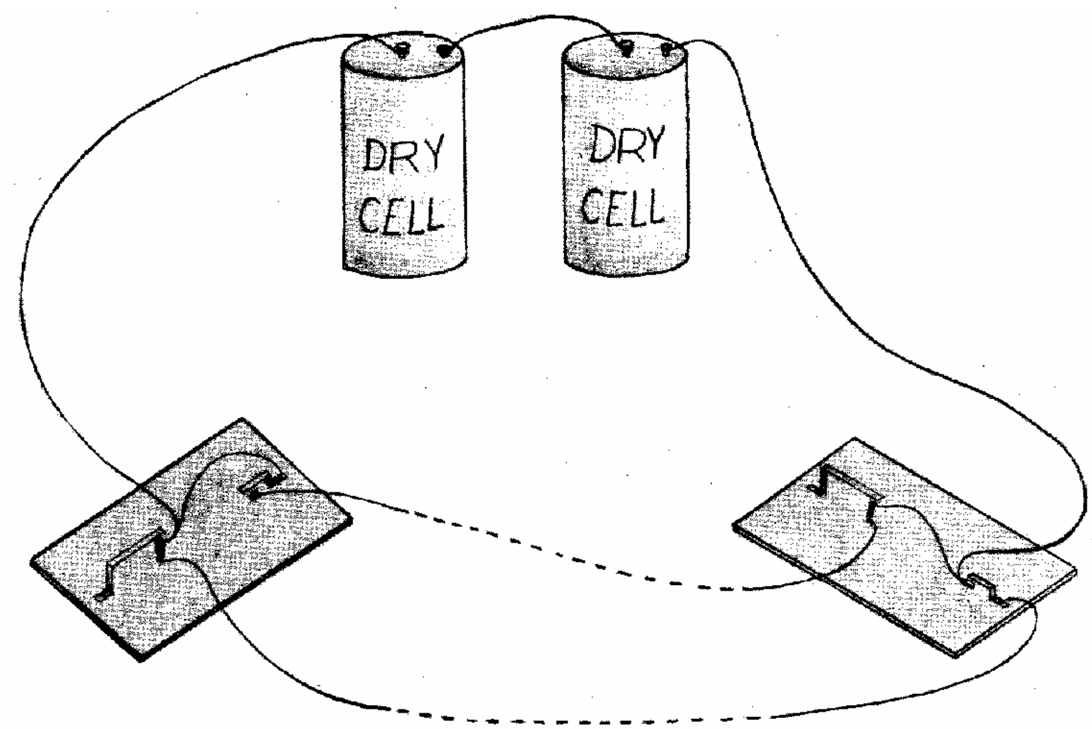


FIG 31·3

The time between the clicks depends on how long you press the tap key. With two fast clicks for a *dot* and two slower clicks for a *dash,* you can send messages in Morse code.

If you wish to send and receive messages from a distance, make a second key and sounder set. Connect the key of one set to the sounder of the other set through two dry cell batteries in series *(Fig 31.3).*

Any one set can be used as a sender and the other as a receiver. You can easily get messages from a distance of 8 to 10 metres. For Morse code, refer to any standard book.

Read the following message in Morse code:

°All electrical connections must be clean and tight.

+You may have to bend the sounder strip to get a good click.

32 Electric Buzzer

Materials

Cardboard

Paper pins

Corks

Enamelled copper wire

Soft iron nail (5-6 cm long)*

Old tin

Shears

Sand paper

Nails

Bob pin

Plasticine

Fresh dry cell

Cello tape

Tap key

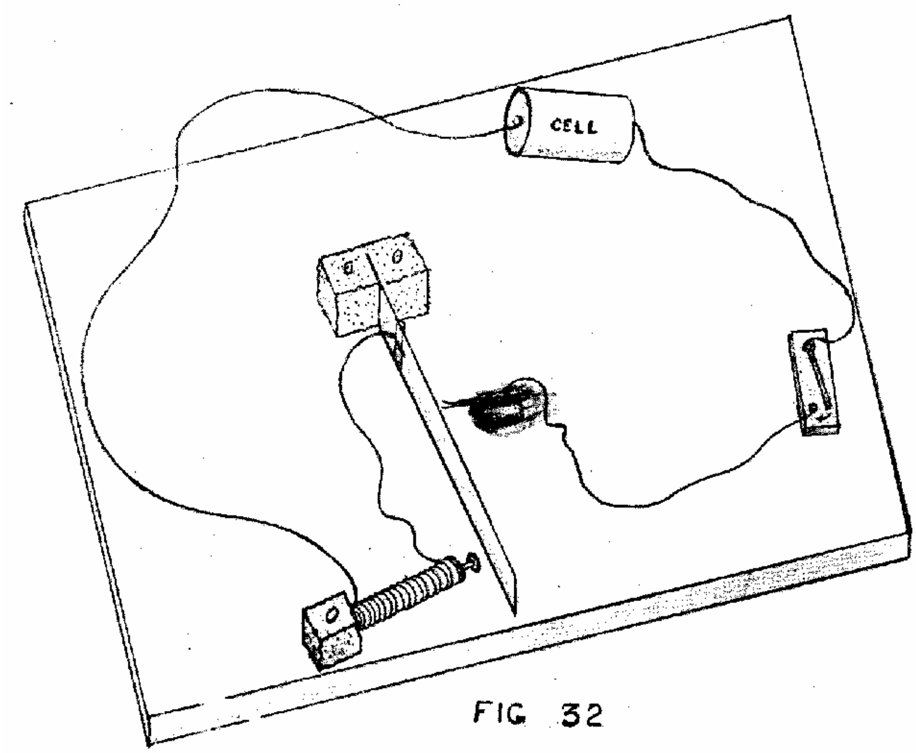


FIG 32

Cut out a piece of cardboard 15 cm x 10 cm. With paper pins fix four small corks to one face of the cardboard such that the cardboard can rest on the corks. The cardboard is the base of the buzzer.

Fix a piece of cork at the pointed end of a 5 cm long soft Iron nail. Wind a couple of metres of enamelled copper wire (in layers) on the remaining part of the nail, leaving about 10 cm at either end. The wired nail .is the electromagnet.

Cut a strip 1 cm wide and 10 cm long from an old tin. Clean the strip with sand paper. Fix one end of the strip to another piece of cork. This strip is the vibrator.

Use nails to fix the two corks to the base such that the free end of the vibrator very *closely* faces the head of the nail.

Open out a bob pin and sand paper it well to remove the paint. Use plasticine to fix the bob pin on the base such that the end of the pin just touches the vibrator. The pin end is the make and break contact.

*See Activity 31.

Use cello tape to connect one end of the wire to a point on the vibrator close to the cork and the other end of the wire to one end of a dry cell. Connect the other end of the cell to the bob pin through a tap key.

The buzzer is ready *(Fig 32).* Press the key and hear the buzz.

If the buzzer does not work when you press the key, decrease the distance between the vibrator and the electromagnet. Adjust the pressure of the pin end on the vibrator to get the loudest buzz.

You will be able to see the sparking at the contact point.

Think out why the buzzer buzzes.

*All electrical connections must be clean and tight.

33 Electric Bell

Materials

Thick cardboard

Handsaw

Soft iron bolt (8 cm long)*

Enamelled copper wire

Cello tape

Old tin

Shears

Corks

Small bolt

Bob pin

Plasticine

High amperage dry cell

Tap key

Gong (or small old tin without lid)

Sand paper

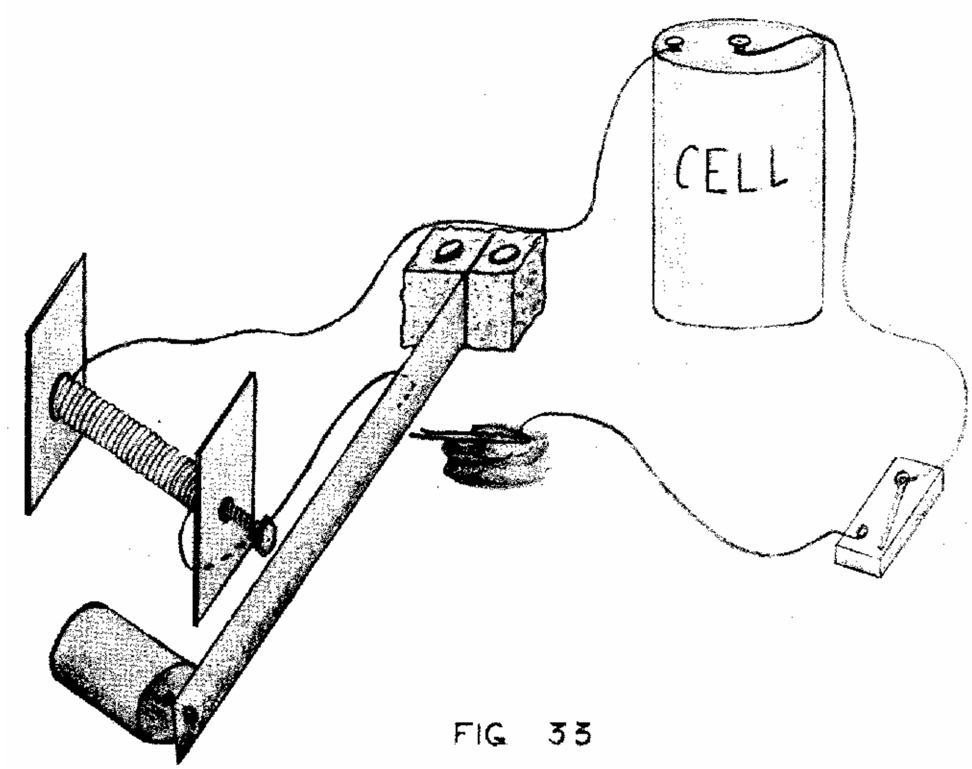


FIG 33

You can easily make an electric bell that will ring with dry ceils. An electric bell is simply an extension of the electric buzzer (Activity 32). Both work on the same principle.

We need;

(a) Bigger *base*—Cut a board 22 cm x22 cm from thick cardboard.

(b) Stronger electromagnet: Use a bolt electromagnet (100-150 turns of enamelled copper wire wound, in layers, on a bolt) in place of a nail electromagnet. Use cellotape to keep the wire in place.

Fix the electromagnet to the base with the help of a cardboard frame and plasticine.

(c) Longer vibrator: About 20 cm long. Fix a piece of cork at one end of the vibrator and a small bolt at the other end. This bolt will serve as the *head* of the vibrator.

*See Activity 31.

Fix the cork (with the vibrator) to the base such that the middle part of the vibrator faces the head of the electromagnet. A part of the vibrator now extends beyond the magnet.

(d) Make *and break contact:* As in the buzzer, anchor a bob pin in plasticine such that the point of the pin just touches the vibrator.

(e) Gong (or open small tin)—the head of the vibrator will strike the gong.

The electrical connections are exactly the same as in the electric buzzer. Make the connections before you mount the gong.

Adjust the contact point and the separation between the vibrator and the head of the electromagnet bolt so that the vibrator vibrates vigorously. Now find the best position for the gong so as to get a lively sound and then fix the gong to the base *(Fig 33).*

The electric bell is ready for use.

Can you say in one sentence the basic principle on which the electric bell (and the electric buzzer) works?

*Check if all connections are clean and tight.

34 Electric Current without a Cell

Materials

Enamelled copper wire

Jar (about 6 cm in diameter)

String

Plasticine

Cardboard

Small compass needle

Magnets

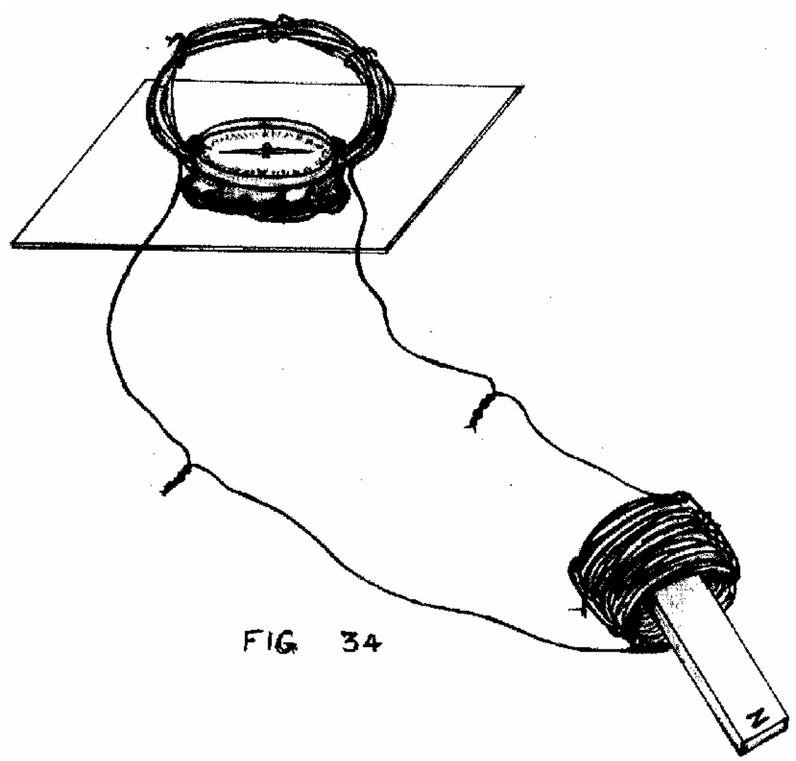


FIG 34

Use the sensitive current detector made in Activity 26 Book 3 or make one thus: Leaving about 20 cm of wire at either end, wrap about 20 turns of enamelled copper wire around ajar (about 6 cm in diameter). Take the jar out and you get a coil of wire.

Tie up small lengths of string at three points of the coil to hold the loops of wire in place.

Cut out a cardboard base 8 cm x 8 cm. With the help of plasticine, fix the coil vertically to the base. Press a small compass needle on the plasticine and symmetrical to the coil.

The current detector is ready. Rotate the base of the detector such that the compass needle is parallel to the coil. Whenever, a current passes through the coif, the needle will be deflected.

Make another coil of about 50 turns, leaving at least 30 cm at either end. Connect this coil to the current detector. Make sure that this coil is far away from the detector.

Hold the coil in your hand and quickly plunge a magnet into it *(Fig 34).*

Let a friend observe the detector needle.

The needle gets deflected and the deflection lasts just for a moment.

Reverse the poles of the magnet and repeat the movement.

The needle now gets deflected in the opposite direction but again for a moment.

Now move the coil instead of the magnet. Again the compass needle shows a momentary deflection. The direction of the deflection depends on the direction of the movement of the coil relative to the magnet.

Carefully note if there is any deflection when the magnet and the coil are both stationary.

You will see that whenever there is a *relative motion* between the coil and the magnet, the compass needle shows a momentary deflection. You have produced electric current without a cell.

35 Quick Crystals

Materials

A Sodium sulphate

Boiling water

Glass jar

Balloon

Rubber band

Magnifying glass

B Pane of glass

Soap

Magnesium sulphate (Epsom salt $MgSO_4$, $7H_2O$)

Test tube (or small bowl)

FIG 35·1

FIG 35·2

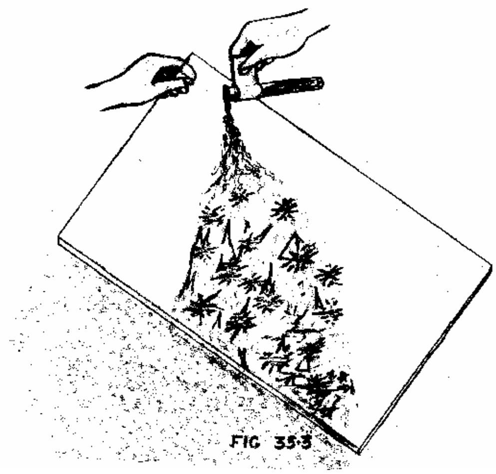


FIG 35·3

A Make a saturated solution* of sodium sulphate in *boiling water.* The solution should be boiling hot.

Warm a glass jar and pour the solution into it.

Cut a part of a balloon large enough to cover up the mouth of the bottle well. Use a rubber band to tie the mouth of the jar with this piece of rubber *(Fig 35.1).*

Allow the saturated solution to cool without disturbance.

Break the rubber cap.

Crystals form immediately *(Fig 35.2).*

You can see them with the naked eye.

Look at the crystals through a magnifying glass.

You will easily see the facets (Ie the tiny faces) of the crystals.

B Clean thoroughly a pane of glass with soap and water. Allow it to dry. Make a saturated solution of magnesium sulphate in boiling water in a test tube. Pour the boiling solution over the clean pane of glass. In a short time, crystals make a network of needles on the glass (Fig *35.3).*

*Keep adding the salt (sodium sulphate) little by little and stirring till no more will dissolve. The solution is then saturated.

36 Tyndall Effect

Materials

Hypo (Sodium thiosutphate hexahydrate,* $Na_2S_2O_3\ 6H_2O$*) Water*

Acetic Acid (or vinegar)

Empty rectangular box (e.g. a shoe box)

Flashlight

Short glass container (e.g. empty pill bottle)

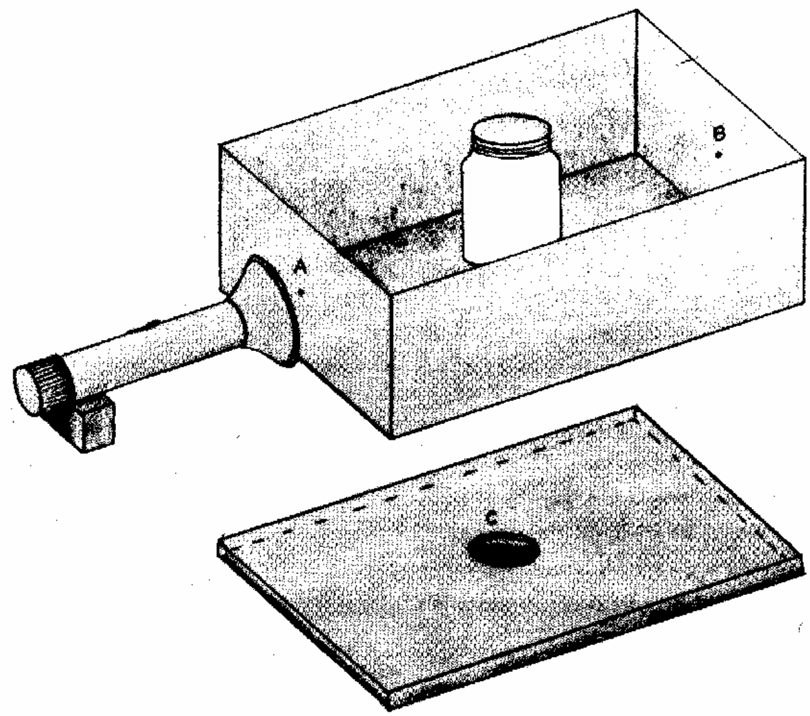


FIG 36

Dissolve one teaspoonful of hypo in about 5 teaspoonfuls of water and form a solution. Add 5 to 10 drops of acetic acid to the solution.

In a couple of minutes, the solution will turn milky because of free sulphur formed. This is a "Colloidal Solution".

Make a 2-3 mm hole in the centre of each end of a rectangular box. Let us call the holes A and B. Make a hole of diameter 2 cm (soy hole C) in the top cover of the box. Cover the box.

Place a lighted flashlight in such a way that the light enters through A. Look at A through B and then through C. You can see the lighted hole only when viewing it through B. No light will be seen while looking through C.

Now place the colloidal solution in the box under the hole C and in the light from the hole A *(Fig 36)*. Cover the box and again look through C.

What do you observe?

You can now see light.

This is the Tyndall Effect—namely scattering of light by a colloidal suspension.

Repeat the activity with dilute milk.

Check if you get the Tyndall effect with sugar solution and hypo solution before adding the acid.

*Sold as hypo-crystals or fixer from any photographic shop,

37 Phases of the Moon Model

Materials

Thick paper Pencil Scale

Cello tape

Small plane mirror (soy 2.5 cm x2.5 cm)

Thick cardboard (or plywood)

Pair of compasses

Paper fastener (preferably brass)

Marbles

Black and white paint

Quick fix

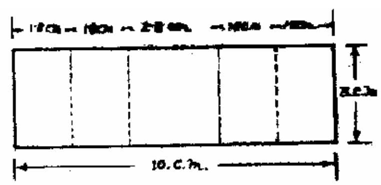
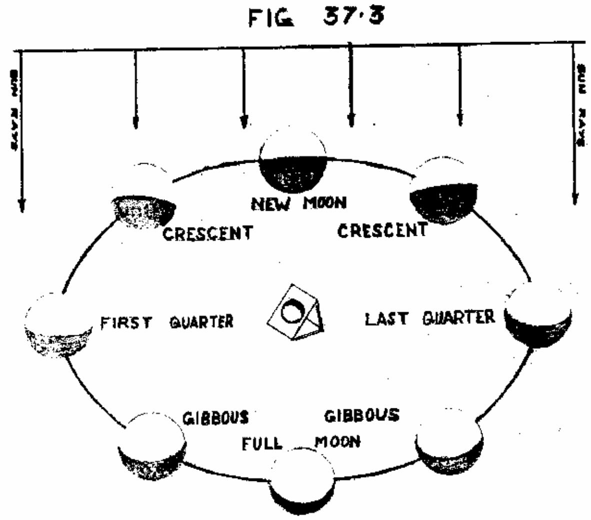


FIG 37·1

FIG 37·2

FIG 37·3



Draw lines across a 3 cm x 10 cm thick paper at 1.8 cm and 3.6 cm from both the ends *(Fig 37.1).* Fold the paper at each line with the line on the inside of the fold. Overlap the four parts and tape them so as to get a triangular prism with open ends. *(Fig 37.2).* Make a hole for a paper fastener in the centre of one of the narrow sides of the prism. With quickfix, attach a small mirror to the wide face of the prism. We shall soon see the phases of the moon in this mirror.

Cut out a piece of cardboard 20 cm x 20 cm. This will be the base of the model.

Draw a circle of 8 cm radius at the centre of the cardboard base. On a line from the centre of the circle to one of the corners of the board, mark a point on the circumference of the circle. From this point, divide the circumference into eight equal parts,

From one of the edges of the base draw arrows to represent the direction of the sunlight.

Make a small hole at the centre of the circle. With a paper fastener, attach the paper prism (along with the mirror) to the centre of the base.

Prepare eight moons by painting one half of each marble white and the other half black. When the paint has dried, use quickfix to attach a ball at each of the eight points on the circle with white side of each ball facing the sunlight.

The model of the phases of the moon is ready.

Look into the mirror and adjust the eye and the cardboard base until you see any one of the phases of the moon. Hold the mirror *stationary* (with the help of the paper fastener), turn the base clockwise, keep looking into the mirror and see the phases of the moon as they actually appear in the sky.

Now label the phases of the moon *(Fig 37.3).*

38 Make an Astrolabe and find Latitude

Materials

Weight (small screw, nut, washer)

String

Protractor

Paper

Glue

Cello tape

Magnetic compass

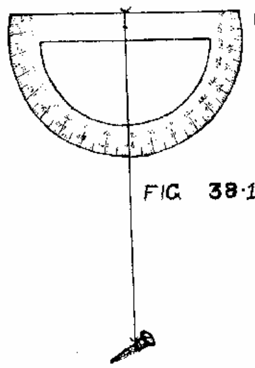


FIG 38·1

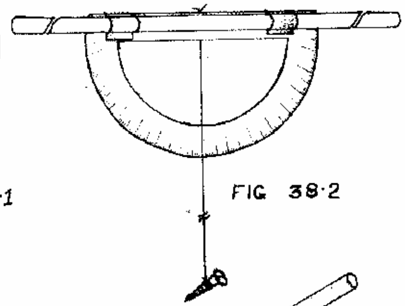


FIG 38·2

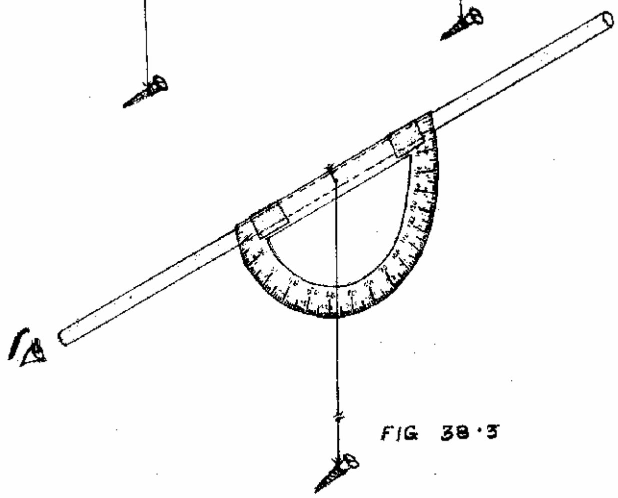


FIG 38·3

Tie a weight to one end of a length of string. Tie the other end to the centre of the base of a protractor* directly under the 90°-mark.

Invert the protractor. The weighted string should now cross the 90°-mark *(Fig 38.1)*. Roll up a piece of paper to form a long narrow tube, and paste the flap with glue. Tape the tube to the base of the protractor *(Fig 38.2)*. The Astrolabe is ready.

Go out in the open at night. Find the approximate north with a magnetic compass. Rotate the protractor (tube side up) until you are able to look at the 'pole star' or the 'north star' through the tube. Adjust so that the star is along the axis of the tube *(Fig 38.3)*.

Note the angle which the string makes with the 90°-mark on the protractor. (Let a friend help you note it as you adjust the tube).

This angle gives the angle of the pole star above the horizon at the point of observation, and is equal to the latitude of that point.

Do you know why? Repeat several times.

*If you do not have a protractor, make one from cardboard.

39 Demonstration of Pascal's Principle

Materials

Rubber tubing

Funnel

Glass tube

Hot water bag

Cork

Water

Books

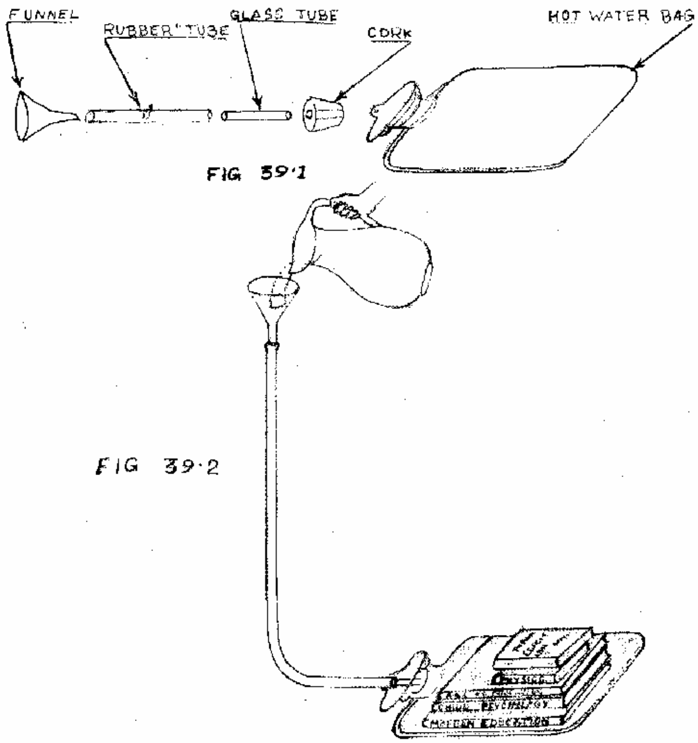


FIG 39·1

FIG 39·2

Take a rubber tube about a metre long. Fit a funnel at one end of the tube and a glass tube at the other end. Make sure that the connections are tight,

Take a hot water bag and find a cork that will fit the bag well. Make a hole in the cork so that the glass tube will sit firmly in the cork (Fig *39.1).*

Half fill the bag with water and cork it. Hold the funnel high and keep the bag on a flat surface *(say* a table). Place a few heavy books on the bag.

Pour water into the funnel *(Fig 39.2).*

What do you observe?

The books are raised.

The more water you add, the higher the books rise.

Explain this by Pascal's Principle.

40 Match the Fingers of your Hands

Materials

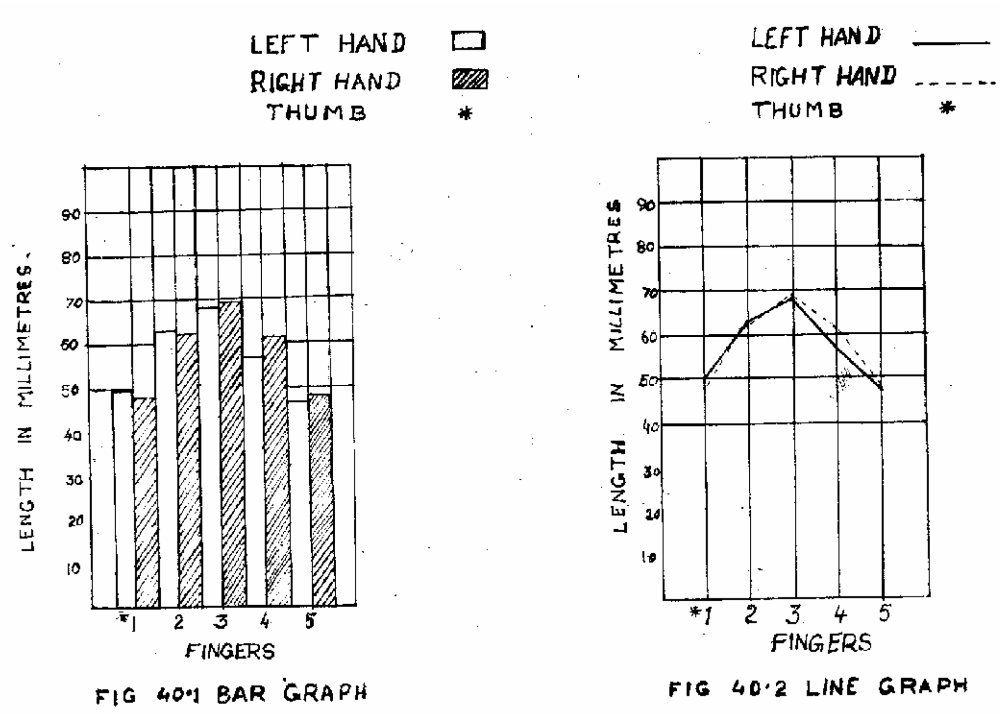
Paper (preferably unruled)

Pencil

Two sheets of graph paper

15-cm scale

Blue and Red colour crayons (any two different colours)



GRAPH OF FINGERS

With the palm up, draw an outline of each of your hands on a sheet of plain paper. Take the help of a friend, if necessary.

Measure the length in millimetres of each finger from the base line to the top of the finger. Record your readings as follows:

Hand	Finger	Length (in mm)
Right	Thumb	
	Fore-finger	
	Middle finger	
Left	Thumb	

On a graph sheet, mark 5 equal distances *say* 10 divisions on the x-axis for the fingers with the thumb as number one. Mark y-axis to indicate millimetres—soy I division to represent 1 mm.

Bar Graph: To represent the length of a thumb (soy of the right hand), draw a rect-angle at I with base as 5 divisions to the right along the x-axis and height equal to the length of the thumb in millimetres. Colour the rectangle red.

In the same way, draw a rectangle to the left of 1 for the thumb of the left hand and colour it blue.

Repeat for the remaining fingers at 2, 3, 4 and 5.

You have a Bar Graph *(Fig 40.1)*.

Line Graph: To mark the length of a right hand thumb, make a dot on the graph along the vertical line at 1 at a distance equal to the length of the right hand thumb in millimetres.

Similarly, make a dot for the length of the left hand thumb along the same line. Repeat for the lengths of the rest of the fingers at 2, 3, 4, 5. Join the dots for the right hand by a red line and for the left hand by a blue line.

You have a Line Graph *(Fig 40.2),*

Find out if

(a) The corresponding fingers on your two hands are of the same size.

(b) Your second finger is shorter or longer or equal to your fourth finger,

(c) Your friend has longer (or shorter) fingers than you. Are you surprised? What do you think are the uses of a graph?

Explanations of Activities

The potato at each end seals the tube. As the pencils are pushed in, the air pressure inside the tube increases until it is strong enough to overcome the friction which holds the first potato in the tube. This air under pressure pushes the potato with considerable force. The pressure *suddenly* reduces and we hear a loud pop.

The total pressure on the air in the lower tin is equal to the sum of atmospheric pressure and that produced by a column of water from the funnel level to the water level in the tin.

This is also the pressure on the water surface in the higher tin because the two are connected together by rubber tubing. This pressure being higher than atmospheric pressure forces out the coloured water from the tin. The process goes oh till the tin is almost empty.

The height of the straw below the liquid surface depends on the ability of the liquid to support solid bodies i.e. on its density. The higher the density of the liquid, the higher will be the height of the straw above the liquid surface and *smaller* will be the length of the straw *below* the liquid level.

The candle heats the water in the tin, the water turns into steam and expands. The steam forces itself through the small opening in the base of the tin. This opening acts as a nozzle of a rocket engine. The action force due to the steam escaping through the hole creates a reaction. This reaction force makes the boat move in a direction opposite to that in which the steam comes out.

When the match-head inside the foil becomes hot enough, it ignites and some of the materials on the match change from a solid to a gas. The gases escape through the channel and exert a force on the foil in the opposite direction and the foil rocket is propelled into the air.

The only downward force acting on falling objects is Gravity. Hence objects reach the floor at the same time irrespective of whether there is any propulsion to the side or not.

The CG of the unloaded pencil is near its geometrical centre. Balancing it on its point is impossible because the CG is higher than the supporting point (pencil point). The CG left to itself tends to be lowest; so the pencil topples over.

The loaded wires bring the CG of the system (wires and pencil) to be below the point of support. Now when the pencil is tilted the CG is *raised.* The CG tries to go lowest and in the process the pencil rocks and comes to rest in the balanced position.

Draw a diagram and satisfy yourself of the above. Remember that in this object (pencil plus weights) the CG is actually outside the object. Compare with Activity No 11, Book 4 on *rocking toys.*

9 The heavy head of the hammer helps in bringing the CG of the ruler hammer system to be vertically below the point of support of the ruler on the table. Hence, the system is balanced (Activity No 9, Book 4). Tilting raises the CG of the system, the CG tries to go to the lowest position and in doing so the system rocks around the point of support.

10 The wire bits lower the CG of the egg. Hence, even on tilting, the CG lies above the point of support of the egg on the brick and the shell does not fall off. Since the CG is raised in the process (exactly as in Rocking Clown Activity No II, Book 4), the shell returns to the original position. Humpty Dumpty refuses to fall.

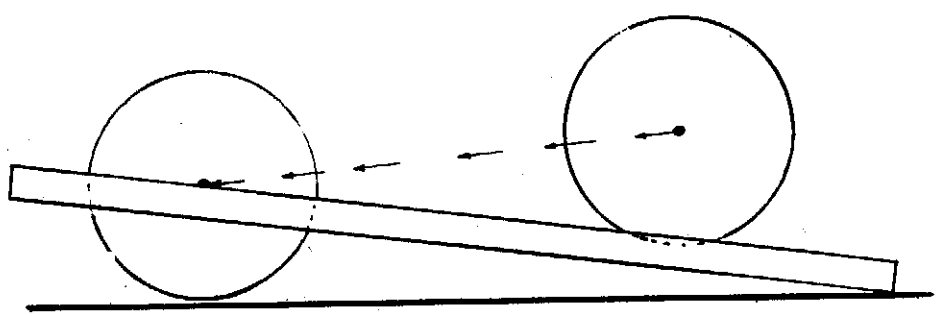


FIG. 11.4

11 The double cone sits higher near the taped end of the scales than when near the open end (Fig *11 A).* So CG is higher when the cone is nearer the taped end. CG always tries to go lowest (Activity 13, Book 2). Hence the cone rolls uphill (towards the book) so as to lower its CG.

12 The weighted string is used herein simply to show the vertical from the CG. As long as the vertical line through the CG falls within the base of the tower, the latter is stable, i.e. it does not fall.

All vehicles are made such that their CG is low so that they can be more stable on steeply inclined roads.

For the same reason heavily loaded trucks are unstable because their CG is too high.

13 Both the book and the rubber band fall under the influence of gravity with the same acceleration. Hence, it appears that with respect to the rubber band the book has no weight. The rubber band book system is weightless relative to itself as it *falls.*

14 a Wheel barrow — II; b Sugar tongs — III; c Pair of Scissors — I; d Air bellows — II; e Paper cutter — II; f Tin opener — II; g Pair of compass—I; h Nut cracker — If; J Claw hammer — I; k Crocodile clip—I.

15 The candle heats the air around and over it. This warm light air rises up the tube over it. Cooler air comes in through the other tube to take it's (warn air's) place. This circulation of air is called convection current. It is a small scale wind which we cannot see. The smoke acts as a tracer and makes the air movement visible to the eye.

The burning candle represents the equatorial regions of the earth. The heated air in this region is pushed up and starts flowing towards the poles. Cold air from the poles flows towards the equator. This is how winds blow.

16 The burning temperature of paper is higher than the boiling point of water (and oil). The water takes away the heat from the flame before it can heat the paper to its burning temperature.

When the water is not there, the heat from the flame raises the temperature of the pan continuously. When the burning temperature is reached, the paper pan burns.

17 *Impurities Lower the Melting / Freezing temperature*

Where the salt meets the ice, the freezing point is lower than 0°C, the ice melts a little and the string goes down. When the salt has spread, the freezing point rises and the ice freezes again. The string gets enclosed by ice and hence you can easily lift the block.

Pressure *also lowers the Melting / Freezing Point*

Pressure of the hands lowers the melting point of ice below 0°C. Hence, ice melts along the contact of the different pieces. When the pressure is released, the freezing point goes up, the molten ice freezes and joins the pieces together and forms a ball because of the round shape of the palms.

In the same way, try to explain how due to the increased pressure of the loaded wire, the wire is able to cut through the block of ice without breaking it.

This is why skating is possible an ice. You skate on a layer of water and not on ice.

18 The sound of the beating of the heart is able to travel through the funnels, rubber tubing and the air inside them without much spreading and directly reach the ears. The heartbeats can thus be heard clearly.

During running, muscles need more oxygen; so the heart has to work faster to provide more blood to them.

19 When light passes from water into air, It bends away from the normal. A ray of fight, striking the water surface at an angle of about 48°.5, comes out parallel to the surface.

A ray, striking the under water surface at an angle greater than 48°.5 will not be able to go out of water at all. It will reflect from the surface of water as a mirror. This is called *total reflection.* So the pin is not visible when the disc is large enough to stop the rays striking the under water surface at less than 48:5.

20 The curved surface of the water drop acts as a lens and forms a magnified Image of the object in the same way as a glass lens.

The flatter a drop, the smaller will be the magnification. The rounder a drop, the larger will be the magnification.

21 The water between the water surface and the mirror surface (inside water) acts as a prism and breaks up the sunlight into rainbow colours. The mirror reflects the colours on to the wall.

When the water is stirred, the colours combine together and produce white light.

22 Normally we see that shadows are sharp and we cannot see around corners. Light travels in straight lines (Activity 18, Book I).

When light passes through small openings, waves of light do bend. This bending is called *Diffraction.*

The pattern of brushes is formed by *diffraction* of light waves passing through the holes made by crossed sets of wires in the mesh and crossed sets of threads in the cloth. The pattern depends on the type of the mesh the light passes through.

23 Lines that cross other lines at an angle seem to affect the way we see straight or curved lines. But no one seems to know how.

We use our eyes to see but the eyes really only let the light in. Inside our eyes, there are special nerve cells that send small signals to the brain when light hits them. It is the brain that interprets these messages. The brain is quite complicated. Scientists still do not know the method used by the brain to interpret messages.

24 It seems that the signals that reach the brain can make sense in more than just one way. When we stare at the cubes (or the vase), our eyes move although we do not realize that they move. When we look at one place on the cubes, the signals received are interpreted as the white surfaces looking like the top of the cubes. When the eyes shift, the cubes pop into another position with the white surfaces looking as the bottom of the cubes. Since the signals make sense both ways, the cubes can be seen in two different ways and so their number is sometime six and sometime seven. In the same way, the vase and the profile also alternate.

Some scientists explain the grey patches where the white lines meet as an attempt by the brain to fill up the white spaces between the black corners.

No one knows exactly how the disc produces the illusion of colour from black and white.

25 The pattern of filings is made of lines. Most of these lines are curved. The curved lines of filings run from one pole to the other pole of the magnet and also radiate outward from both the poles.

Scientists say that the iron filings are arranged along the lines of *magnetic* force. A magnet has a field of force surrounding it. Tapping helps the filings to align with the lines of magnetic force.

26 Rubbing gives negative charge to the Perspex sheet. When the aluminium dish is placed on the sheet, the high negative charge on the sheet repels the negative charge near the bottom to the inner surface of the dish *(Fig 26.1).*

When you touch the rim of the dish with your finger, the electrons are drained away from the surface of the dish through your body to the earth *(Fig 26.2).*

When you remove your hand and pick up the dish by the handle, the positive charge remains on the dish because the candle is an insulator. The electrophorus is thus positively charged *(Fig 26.3).*

The positively charged electrophorus attracts electrons from metal objects and your friend and this creates a spark *(Fig 26.4).*

Note that the charges do not move from the Perspex sheet to the aluminium dish.

Perspex is an insulator. This method of giving objects a static charge is called charging by *induction.*

Nothing happens (no spark passes) when two charged electrophorus dishes are brought near because both are short of electrons.

27 When the positively charged electrophorus comes near to the metal clip, the electrons in the clip are attracted to be near the electrophorus. The foil leaves become charged positively and repel each other and separate (Fig 27.2).

When you touch the clip with your finger, the electrons from your hand neutralize most of the positive charge on the leaves and the separation decreases *(Fig* 27.3). When you remove the finger first and then the electrophorus, the negative charge on the clip spreads all over, the leaves again become similarly charged (but now negatively) and hence separate again *(Fig 27.4).*

To charge the electroscope with a positive charge, in Fig 27.2, bring a negatively charged body, say a polythene sheet rubbed with cloth, near the metal clip and go through the same steps as before.

28 The electrophorus is positively charged and attracts the electrons in tin .1 on its own side. The opposite side of the tin thus becomes positively charged and attracts the neutral aluminium ball.

Some of the electrons from the ball go to the tin and thus the ball also becomes positively charged. The ball and tin I now repel one another and the ball swings over to tin 2.

The ball now picks up electrons from tin 2 and becomes neutral again. It swings away from tin 2 and bumps into tin I again and the process is repeated.

Every time the ball touches tin I, it leaves some electrons with tin I. Every time, it touches tin 2, it takes some electrons from tin 2. The electrons are thus *ferried* from tin 2 to tin I.

If you touch the tin I while the ball is oscillating, the electrons from the hand go to tin I and neutralize the charge. So the ball stops moving.

Wax is not a very good conductor of electrons and makes it difficult for electrons to get on or off tin I and the tin I is able to retain its charge for some time. Of course, there is always leakage through the air and slowly the tin loses its charge. You have to charge it again to have the ‘electron ferry’.

29 Resistance (electrical) of a wire is more when it is heated than when it is cold. So as the wire becomes hotter, its resistance increases and the current through the bulb decreases.

The light given out by a bulb depends on the current passing through it. The smaller the current, the lesser the light. So the bulb grows dimmer.

30 When the tap key is closed, there is an electric current in the coil. This produces a magnetic field. The field inside the coil is strong enough to lift the steel wire up. When the tap key is open, the current is no longer passing through the coil. The magnetic field disappears. Gravity pulls the wire down.

An electric hammer works on this principle.

31 When the tap key is pressed, an electric current passes through the wire, the nail acts as an electromagnet and the sounder strip is attracted to the nail. The strip clicks against the head of the nail.

When the key is released, the nail is no longer a magnet and the sounder strip is released.

Message in Morse code is: I do and I understand.

32 When the switch (tap key) is closed, the electric current passes from the dry cell through the coil of wire along the vibrator to the point of the bob pin, through the pin to the tap key and then back to the cell. The electric circuit is thus completed and the nail becomes an electromagnet and pulls the vibrator towards the head of the nail. This *breaks* the contact with the end of the bob pin.

The circuit is no longer complete. There is now no current through the coil, the nail is no longer an electromagnet and does not pull the vibrator. The vibrator goes back and the contact with the pin end is again established. The circuit is now again complete and the process is repeated so rapidly that the strip vibrates with a buzzing sound.

33 The electric bell works on the principle of quickly making and breaking an electric circuit.

34 Whenever magnetic lines of force are cut by a closed coil, a current is setup in the coil. This current causes the deflection of the compass needle.

This effect is called electromagnetic induction. The current is called induced current.

No current is induced when the magnet is at rest inside or outside the stationary coil.

This principle is used for generation of electricity by dynamos.

36 A colloid mixed with water does not give a solution (like sugar in water) but a suspension. Milk is a colloidal suspension. Sulphur obtained by adding acid to hypo solution is a colloidal suspension.

Particles in a colloidal suspension are larger than molecules and scatter light in all directions. So we can see light when looking through the hole C (with colloidal suspension in place).

38 The pole star is directly overhead at the North Pole. Thus the latitude at the North Pole would be 90°. The pole star would be directly along the horizontal when seen from the equator. Thus the latitude at the equator would be 0. So we have the rule: ‘The latitude at any given place is equal to the elevation of the pole star at that place.’

39 According to Pascal's Principle: Pressure applied to a confined fluid (fluid completely fills a vessel) is transmitted undiminished to all parts of the fluid and to the walls of the containing vessel.

The pressure due to the addition of water in the tube is thus transmitted unchanged to the water in the bag and the walls of the bag.

The surface area of the bag is much greater than the surface area of the water in the tube—*say* it is 'n' times greater.

The force on the walls of the bag is thus multiplied 'n' times (Force = Pressure x Area). This large force is able to raise the books.

Pascal's Principle has a number of practical applications. The brakes of many vehicles work on hydraulic pressure. Hydraulic press has many industrial applications like pressing of cotton bales and waste paper into compact bales.

40 A graph gives information at a glance. Whenever you come across two (or more) related quantities, you can draw a graph.

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